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PRODROMUS OF A STUDY OF THE FRESH WATER ALGAE OF EASTERN NORTH AMERICA.

By Horatio C. Wood, Jr.,

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For several years all the leisure, my more strictly professional duties allow me, has been devoted to the study of the Alga-fauna of our inland waters, and I had intended delaying publication until ready to offer to the scientific world an elaborate memoir upon the subject. The field is however so constantly enlarging, that the day of final preparation seems rather to recede than draw near. This and the hope of stirring up other laborers, have induced me to print now a very brief abstract of the results that have so far rewarded my efforts. In enumerating and describing the species herein contained, I shall follow the classification and arrangement adopted by Rabenhorst in his "Flora Europœa Algarum." It should, however, be plainly understood that I do not do this, as endorsing the method of the German Professor, but simply because I do not feel prepared at present to discuss the natural arrangement of this group, and desire to leave the whole subject for a future Memoir.

The desire of enlisting the assistance various of observers, as already mentioned, has been one of the motives that have prompted me to publish at this time. I am already greatly indebted to several botanists for aid, amongst whom I may mention Dr. J. S. Billings, U. S. A., Professor H. W. Ravenel, and Mr. William Canby, and am thereby emboldened to ask for more. If there are any persons engaged in the study of these plants, I will be most happy to exchange specimens with them, either fresh or mounted for the microscope; and when occasion may arise, will most freely give all the credit due them for species new to America or Science. If there are others willing to help me, I will do all in my power to aid them in return by labelling specimens, giving information as to books, &c., or make such other returns as circumstances will permit. Any one who is thus willing had better address me by letter, when I will forward to him preservative fluid, with some directions.

A certain amount of experience and knowledge of the subject greatly facilitates the collection of these plants, but scarcely so much as in other departments of cryptogamic botany. Most of the species of fresh water algae are so small that the most experienced algologist does not know how great the reward of the day's toil may be until he places his booty on the object glass of his compound microscope. In order to aid any one who is desirous of collecting and studying these low forms, it seems to me not amiss to make here a few remarks upon the where and the when to look, and the how to preserve after they are found.

There are three or four distinct classes of localities, in each of which a distinct set of forms may be looked for. Stagnant ditches and pools; springs, rivulets, large rivers, and other bodies of pure water; dripping rocks in ravines, &c.; trunks of old trees, boards, branches and twigs of living trees and other aerial localities.

In regard to the first of these—*stagnant waters*—in these the most conspicuous forms are oscillatoriæ and zygnemaceæ. The oscillatoriæ may almost always be recognized at once, by their forming dense, slimy strata, floating or attached, generally with very fine rays extending from the mass like a long, delicate fringe. The stratum is rarely of a bright green color, but is mostly dark; dull greenish, blackish, purplish, blue, &c. The oscillatoriæ are equally valuable as specimens at all times and seasons, as their fruit is not known, and the characters defining the species do not depend upon sexual organs. The zygnemas are the bright green, evidently filamentous, slimy masses, which float on ditches or lie entangled amongst the water plants, sticks, twigs, &c., in them. They are only of scientific value when in fruit, as it is only at such times that they can be determined. Excepting in the case of one or two very large forms, it is impossible to tell with the naked eye with certainty whether a zygnema is in fruit or not; but there are one or two practical points, the remembrance of which will very greatly enhance the probable yield of an afternoon's search. In the first place, the fruiting season is in the spring and early summer. The latter part of March, May and June are the months when the collector will be best repaid for looking for this family. Again, when these plants are fruiting they lose their bright green color and become dingy, often yellowish and very dirty looking—just such specimens as the tyro would pass by. The fine, bright, green, handsome masses of these algae are rarely worth carrying home. After all, however, much must be left to chance; the best way is to gather small quantities from numerous localities, keeping them separate until they can be examined.

Adhering to the various larger ditch plants, to floating matters, twigs and stones, &c., will often be found filamentous algae, which make fine filmy fringes around the stems, or on the edges of the leaves; or perchance one may meet with rivulariæ or nostocs, &c., forming little green or brownish balls, or indefinite protuberances attached to small stems and leaves. These forms are, however, to be looked for especially later in the season. Whenever seen, they should be secured.

In the latter part of summer, there is often a brownish gelatinous scum to be seen floating on ditches. Portions of this should be preserved, as it frequently contains interesting nostocs and other plants.

In regard to large *rivers*, the time of year in which I have been most successful in such localities, is the latter summer months. *Springs* and small bodies of clear water may be searched with a fair hope of reward at any time of the year when they are not actually frozen up. I have found some exceedingly beautiful and rare algae in such places as early as March, and in open seasons they may be collected even earlier than this. The desmids are most abundant in the spring, and possibly most beautiful then. They, however, rarely conjugate at that time, and the most valuable specimens are therefore to be obtained later—during the summer and fall months; at least, so it is said; and the little experience I have had with this family seems to confirm it. *Rivulets* should be watched especially in early spring, and during the summer months.

From the time when the weather first grows cool in the fall, on until the cold weather has fairly set in, and the reign of ice and snow commences, is the period during which the algae hunter should search carefully all wet, *dripping rocks*, for specimens. Amongst the dew bearing stems of wet mosses—in dark, damp crevices, and little grottoes beneath shelving rocks—here, at this season, is the algae harvest to be reaped. Nostocs, palmellas, conjugating desmids, sirosiphons, various unicellular algae, then flourish in such localities. My experience has been, that late in the fall, ravines, railroad cuttings, rocky river-banks, &c., reward time and labor better than any other localities.

The vaucherias, which grow frequently in wet ground, as well as submerged, fruit in the early spring and summer in this latitude, and are therefore to be collected at such times, since they are only worth preserving when in fruit.

In regard to algae which grow on trees, I have found but a single species, and do not think they are at all abundant in this latitude. Farther south, if one may judge by Professor Ravenel's collections, they are the most abundant forms.

As to the preservation of the algae—most of the submerged species are ruined by drying. Studies of them should always, when practicable, be made whilst fresh. Circumstances, however, will often prevent this, and I have found that they may be preserved for a certain period, say three or four months, without very much change, in a strong solution of acetate of alumina. If this is not to be had, I would recommend a trial of a preservative liquid, made of glycerine, carbolic acid (creasote of the shops), and water. This mixture might be made by dissolving half an ounce of pure carbolic acid (a little more of the impure), in three fluid-ounces of glycerine, and adding a full pint of pure water.

Almost all species of algae which are firm and semi-cartilaginous, or almost woody in consistency, are best preserved by simply drying them, and keeping them in the ordinary manner for small plants. When studied, fragments of them should be soaked in water.

The only satisfactory way that algae can be finally prepared for the cabinet is by mounting them whole, or in portions, according to size, for the microscope. Of the best methods of doing this, this is hardly the place to speak; but a word as to the way of cleaning them will perhaps not be out of place. Many of them, especially the larger filamentous one, may be washed by holding them fast upon an ordinary microscope slide, with a bent needle or a pair of forceps, and allowing water to flow or slop over them freely, whilst they are rubbed with a stiffish camels hair pencil or brush. In other cases, the best plan is to put a mass of the specimens in a bottle half full of water, and shake the whole violently; draw off the water from the plants in some way, and repeat the process with fresh additions of water, until the plants are well scoured. At first sight, this process would seem exceedingly rough, and liable to spoil the specimens, but I have never seen bad results from it, at least, when practised with judgment. The water seems so to envelope and protect the little plants that they are not injured.

After all, in many instances it appears impossible to clean these algae without utterly ruining and destroying them—the dirt often seeming to be almost an integrant portion of them; so that he who despises and rejects mounted specimens, simply because they are dirty and unsightly, will often reject that which, scientifically speaking, is most valuable and attractive.

In concluding this introduction, it is perhaps pardonable to state, that there are in my possession elaborate descriptions and drawings (from nature) of nearly all the plants mentioned in this paper, and that of the species mentioned, all but a dozen or two are new to science or new to this continent.

CLASS PHYCOCHROMOPHYCEAE.

ORD. CYSTIPHORAE.

FAM. CHROOCOCCACEAE.

GEN. CHROOCOCCUS.

C. REFRACTUS. *Sp. Nov.*

C. cellulis in familias solidas arcte consociatis, plerumque subquadratis, saepius triangularibus, rare multiangulis; familiis saepius lobatis; cytiodermate tenui, vix visibile, achroo; cytioplasmate subiliter granulato, subfusco vel subluteo, valde refrangente.

C. Cells closely associated together into solid families, mostly subquadrate, very often triangular, rarely multiangular; families often lobed; cytioderm thin, scarcely perceptible, transparent; cytioplasm finely granular, brownish or yellowish, highly refractive.

Diam. cell. $\frac{1}{6000}''$ $\frac{1}{3000}''$, rare in cellulis singulis $\frac{1}{2000}''$; famil. $\frac{1}{1500}''$ $\frac{1}{750}''$.

Hab. In rupibus irroratis prope Philadelphia.

C. MULTICOLORATUS. *Sp. Nov.*

C. in strato mucoso inter algas varias sparsus; cellulis singulis sphaericis, vel 2–4 (rare 8) aut angulis aut semisphaericis aut abnormibus in familias oblongas consociatis; cytiodermate crasso, hyalino, haud lamelloso; tegumentis plerumque nullis, interdum subnullis; cytioplasmate plerumque homogeneo, interdum subiliter granulato, vel luteo-viride vel caeruleo-viride vel luteo vel subnigro, vel brunneo, vel saturate aurantiaco, saepe ostro tincto.

Diam. cell., sing. sine tegm., $\frac{7}{9000}''$ cum teg. $\frac{2}{1500}''$; cell. in famil. sing. $\frac{2}{4500}''$—$\frac{4}{4500}''$. Fam. long. $\frac{7}{4500}''$—$\frac{19}{4500}''$; lat. $\frac{6}{4500}''$—$\frac{7}{4500}''$.

C. Occurring scattered in a mucous stratum with other algae; cells spherical and single, or else angular semisphaerical or irregular and associated together in oblong families of from 2–4 (rarely 8); inner coat thick, hyaline, not lamellate; outer coat generally wanting, sometimes indistinctly present; endochrome mostly homogeneous, sometimes minutely

granular, either a yellowish green or bluish green, or yellowish, or brown, or blackish, sometimes tinged with bright lake.

Hab. In rupibus humidis prope Philadelphia.

GEN. GLOEOCAPSA.

G. SPARSA. *Sp. Nov.*

G. in strato mucoso sociis algis variis sparsa; cellulis sphaericis, vel oblongis vel ovatis, 2–8 in familias consociatis; familiis subglobosis vel subovatis, interdum numeroso-aggregatis; tegumentis internis aureo-fuscis, firmis, rarissime coloris expertibus, homogeneis, vel lamellosis; tegumentis externis achromaticis, rare subachromaticis, plerumque vix visibilibus; cytioplasmate homogeneo.

Diam. max. cell. oblong. sine tegum. long., $\frac{1}{3000}''$; lat., $\frac{1}{7500}''$; cell. glob., sine tegum., $\frac{1}{5000}''$; cum tegum., $\frac{1}{1875}''$; fam., $\frac{1}{750}''$.

G. scattered in a mucous stratum composed of various algae; cells spherical, or oblong, or ovate, associated together in families of from 2-8; families subglobose or subovate, sometimes aggregated together in large numbers; inner tegument yellowish brown, firm, rarely colorless, homogeneous or lamellate; external tegument achromatic, rarely subachromatic, generally scarcely visible.

GEN. MERISMOPEDIA.

M. CONVOLUTA. *Bréb.*

Hab. Prope Philadelphia.

Remarks.—I have only a slide of specimens, which were given me by my friend Dr. J. Gibbons Hunt. Our American form seems to be too close to the European species to be separated from it, although in no case is the frond in any wise plicate or convolute, and the cells are somewhat smaller (long diameter, $\frac{1}{6000}''$).

M. NOVA. *Sp. Nov.*

M. thallo membranaceo, distincte limitato, cellulis numerosissimis composito; cellulis ovalibus, arcte approximatis, 16 in familias consociatis, dilute caeruleo-viridibus, interdum medio constrictis; thalli marginibus rectis, integris.

Thallus membranaceous, distinctly limited, composed of very numerous cells; cells oval, closely approximated, consociate in families of 16, light bluish green, sometimes constricted in the middle; margin of the thallus straight and entire.

Diam. cell. ad. $\frac{1}{4000}''$.

Hab. In flumine Schuylkill, prope Philadelphia.

FAM. OSCILLARIACEAE.

GEN. OSCILLATORIA.

O. NIGRA. *Vauch.*

In stagnis prope Philadelphia.

Remarks.—Our American form does not quite equal the measurements given by Rabenhorst. I have never measured it over $\frac{1}{3400}''$ in diameter.

O. LIMOSA. (*Roth.*) *Agh.*

Hab. In stagnis prope Philadelphia.

Remarks.—The dissepiments are never granulate, at least that I have seen. Otherwise our American forms agree in all respects with the descriptions of the European.

O. NEGLECTA. *Sp. Nov.*

O. trichomatibus modice brevibus, aut dilute purpuraceo-plumbeis aut plumbeo-cinereis, plerumque rectis, aut stratum mucosum atro-purpureum haud distincte radiante formantibus, aut in strato gelatinoso haud radiante subplumbeo dispersis et cum algis aliis intermixtis, rare oscillantibus sed lente sese moventibus; articulis diametro fere 4 plo brevioribus; dissepimentis plerumque haud granulosis, rare indistincte granulosis; apiculo obtuse rotundato, interdum breve nonnihil attenuato.

Filaments rather short, of a dilute purplish lead color, or leaden gray, generally straight, either forming a mucous, blackish purple stratum without marked rays, or diffused with other algae in a gelatinous mass, rarely oscillating but gliding; articles about four times shorter than broad; joints for the most part not granulate, rarely indistinctly granulate; ends obtusely rounded, occasionally shortly somewhat attenuate.

Diam. $\frac{1}{1500}''$=.0066.

Hab. In stagnis prope Philadelphia.

O. IMPERATOR. *Sp. Nov.*

O. in strato mucoso, plerumque natante, olivaceo-atro, longe radiante; trichomatibus rectis aut subrectis, tranquillis, dilute viridibus vel saturate olivaceis, haud oscillantibus, sed ambulantibus; apiculis nonnihil attenuatis, late rotundatis vel subtruncatis, curvatis; articulis diametro 5–12 plo brevioribus, ad genicula indistincte contractis; cytioplasmate homogeneo, olivaceo-viride; vaginis firmis, ad genicula distincte transverse striatis,

O. Occurring in an olive-black mucous stratum, mostly swimming and with long rays; filaments straight or straightish, light green or deep olive, tranquil, not oscillating, but moving with a gliding motion; ends somewhat attenuate, broadly rounded or subtruncate, curved; articles 5-12 times shorter than broad, slightly contracted at the joints; cytioplasm homogeneous, olive green; sheaths firm, distinctly transversely grooved at the joints.

Diam. .002.″

GEN. LYNGBYA.

L. BICOLOR. *Sp. Nov.*

L. trichomatibus simplicibus in cæspites nigro-virides dense intricatis, varie curvatis, plerumque inarticulatis, interdum breve articu-

latis et ad genicula contractis; cytiodermate dilute caeruleo-viride, plerumque copiose granulato, saepe interrupto; cellulis perdurantibus cylindricis, saepe elongatis, saturate brunneis, sparsissimis; vaginis firmis, achrois, in trichomata matura modice crassis.

L. with the filaments closely interwoven into a blackish green mat; filaments variously curved, simple, mostly inarticulate, sometimes shortly articulate with the joints contracted; endochrome light bluish green, mostly very granulate, often interrupted; heterocysts cylindrical, often elongate, deep brown, very few; sheaths firm, transparent, in old filaments moderately thick.

Diam. $\frac{1}{1700}''$.

Hab. In flumine Schuylkill prope Philadelphia.

FAM. NOSTOCHACEAE.

GEN. NOSTOC.

N. CALCICOLA. *Ag.*

Hab. In rupibus prope Catoosa Springs, Georgia.—Prof. Ravenel.

Remarks.—The heterocysts in the American plant are both intermixed and terminal, otherwise the description of the European form is well answered. The region of country in which the specimen was collected is a limestone one. I am unable to say more positively whether the rocks on which it was growing were limestone or not.

GEN. SPHAEROZYGA.

S. POLYSPERMA. *Rabenhorst.*

In stagnis prope Camden, New Jersey.

S. SUBRIGIDA. *Sp. Nov.*

S. natans; trichomatibus singulis, rectis aut subrectis, minimis, dilute viridibus; articulis cylindricis aut subglobosis, distinctis; sporis cylindricis, in medio gradatim nonnihil constrictis, singulis aut duplicis, sine cellulis perdurantibus inter se; cellulis perdurantibus brevecylindricis, singulis, distinctis.

S. Floating; filaments single, straight or straightish, very small, light green; articles cylindrical or subglobose, distinct; spores single or double, in the middle gradually a little constricted, not having a heterocyst between them; heterocysts shortly cylindrical, single, distinct.

Diam. cell. veg. trans. $\frac{1}{6000}''$=.00016; spor. transv. $\frac{1}{4300}''$–$\frac{1}{4500}''$= .00023″–.00022″; long. $\frac{1}{1500}''$=.00066″; cell. perd. transv. $\frac{1}{4500}''$=.00022.

Hab. In stagnis prope Philadelphia.

GEN. CYLINDROSPERMUM.

C. FLEXUOSUM. (*Ag.*) *Rabenh.*

Hab. In humo irrorato prope Philadelphia.

C. MINUTUM. *Sp. Nov.*

C. trichomatibus dilute aerugineis, plerumque flexuoso-curvatis et intricatis, interdum subrectis; articulis cylindricis, ad genicula plus minus constrictis, homogeneis vel granulatis; cellulis perdurantibus terminalibus, hirsutis, globosis; sporis ellipticis, diametro 2-3 plo longioribus, subtilissime granulatis.

Filaments light aeruginous green, generally curved and intricate, sometimes straightish; articles cylindrical, more or less constricted at the joints, homogeneous or granulate; heterocysts terminal, hirsute, globose; spores elliptical, 2-3 times longer than broad, very minutely granulate.

Diam. Artic. $\frac{1}{9000}''$; spor. long. $\frac{1}{1830}''$; transv. $\frac{1}{4000}''$.

Hab. In stagnis prope Philadelphia.

GEN. ANABAENA.

A. GELATINOSA. *Sp. Nov.*

A. thallo mucoso gelatinoso, indefinite expanso, dilutissime brunneo, nonnihil pellucido; trichomatibus haud vaginatis, leviter flexuoso-curvatis, nonnihil distantibus, haud intricatis, aut dilute aureis aut dilute caeruleo-viridibus; articulis globosis, homogeneis; cellulis perdurantibus articulorum diametro fere aequalibus, globosis, vel rare oblongis; sporis terminalibus, singulis, globosis, (fusco-brunneis?)

Thallus gelatinous, mucous, indefinitely expanded, somewhat pellucid, with a brownish tinge; filaments not vaginate, somewhat curved, rather distant, not intricate, either a light golden yellow or light bluish green; joints globose, homogeneous; heterocysts about equal to the filament in diameter, globose or rarely oblong; spores terminal, globose.

Hab. Prope Philadelphia.

GEN. NOSTOCHOPSIS. *Gen. Nov.*

Trichomata ramosa cum cellulis perdurantibus aut in latere sessilibus aut in ramulorum brevissimorum apicibus dispositis. Vaginae nullae. Thallus definitus.

Thallus definite; filament branched; heterocysts sessile upon the sides of the filaments or raised upon the apices of short branches; sheaths none.

Remarks.—The curious plant upon which this genus is founded has the habit of a nostoc. The outer portion of the frond is condensed so as to give the appearance of a periderm; there is, however, no true periderm. The consistence of the thallus is that of a firm gelatinous mass. The trichomata or filaments radiate from the inner part of the frond towards the outer surface, but many of them take their origin in the outer portions of the thallus. In most places they are distinctly articulated, and indeed often seem to be composed of globular cells, resembling the filaments of a nostoc; on the other hand in certain portions they are not at all articulated. No sheaths are anywhere visible. The heterocysts are strangely enough never placed in the continuity of the

filaments. Sometimes they are sessile immediately upon the latter, sometimes they are raised upon very short branches. They are globose with rather thick walls. No spores were discovered. It seems to me best for the present to class this curious plant with the nostochaceae, although I am not altogether satisfied as to its affinities.

N. LOBATUS. *Sp. Nov.*

N. thallo vivide viride aut luteo-viride, cavo, enormiter lobato, natante, modice magno, firmo, gelatinoso; trichomatibus plerumque longis, flexuosis, dilute viridibus, plerumque articulatis, partim inarticulatis, cylindricis aut sub-moniliformibus, sparse granulatis.

Diam. trichom; cell. perdur.

Remarks.—I found this plant floating upon the Schuylkill river just above Manayunk. The hollow frond was buoyed up by a bubble of gas contained within it. It was an irregular, flattened, somewhat globose mass, of a bright green color and about $\frac{1}{2}$ an inch in diameter. It seems very probable that in its earlier condition, it was a solid attached frond. The long slender filaments are often very tortuous, but run a pretty direct general course towards the outer surface.

FAM. RIVULARIEAE.

GEN. GLOIOTRICHA.

G. INCRUSTATA. *Sp. Nov.*

G. globosa vel subovalis, firma, solida, ad pisi minimi magnitudinem, dilute viridis, crystallophora; trichomatibus rectis aut leviter curvatis, in pilum productis, viridibus aut flavescentibus, saepe infra laete viridibus sed supra flavescentibus, haud ordinatim articulatis; articulis inferioribus in trichomatibus maturis brevibus, plerumque compressis; pilo apicale recto aut leviter curvato, plerumque indistincte articulato, saepe interrupto; vaginis amplis, achrois, saccatis, interdum valde constrictis; sporis cylindricis, saepe curvatis, diametro ad 9 plo longioribus; cellulis perdurantibus sphaericis.

Diam. trichom. cum vag. $\frac{7}{7500}''$–$\frac{9}{7500}''$ sporis max. $\frac{3}{7500}''$–$\frac{4}{7500}''$; cell. perd. $\frac{7}{15000}''$.

Frond globose or suboval, firm, solid about the size of a very small pea, light green, crystal bearing; filaments straight or slightly curved, produced into long hairs, green or yellowish, sometimes bright green in their proximal portions but yellowish above, not regularly articulate; lower articles in the mature filament short, and generally compressed; apical hair—like portion straight or slightly curved, mostly indistinctly articulate, frequently interrupted; sheath ample, transparent, saccate, sometimes strongly constricted; spores cylindrical, frequently curved, about 9 times as long as broad.

Hab. Schuylkill river, plantas aquaticas adhaereus.

GEN. RIVULARIA.

R. CARTILAGINEA. *Sp. Nov.*

R. subglobosa, parva, cartilaginea, saturate brunnea vel sub-atra, solitaria in plantis aquaticis :—trichomatibus maturis sterilibus rectis aut subrectis, cylindricis, elongatis, haud articulatis ; cytioplasmate saepe interrupto ; vaginis arctis et distinctis ; cellulis perdurantibus globosis, diametro subaequalibus :—trichomatibus fertilibus rectis aut sub-rectis, supra spora cellulis 8-9 instructis ; sporis elongatis, rectis, cylindricis ; vaginis nonnihil crassis, arctis :—trichomatibus immaturis, breve articulatis ; vaginis subamplis.

Frond subglobose, small, cartilaginous, deep brown or blackish, solitary upon aquatic plants : mature sterile filaments, cylindrical, elongated, not articulated, their cytioplasm frequently interrupted, their sheaths close and distinct, their heterocysts globose and about equal to them in diameter ; fertile filaments straight or nearly so, above the spores furnished with 8 or 9 cells ; spores elongate, straight, cylindrical ; sheaths rather thick, close ; immature filaments shortly articulate, their sheaths rather large.

Diam. trich. cum vag. $\frac{1}{2000}''$; spor. $\frac{1}{3000}''$.

Hab. In palude, Northern Michigan.

GEN. DASYACTIS.

D. MOLLIS. *Sp. Nov.*

D. parva, ad magnitudinem pisi minimi, enormiter subglobosa, mollis, gelatinosa, dilute viridis, haud distincte zonata ; trichomatibus plerumque subrectis, partim distincte, partim indistincte articulatis ; vaginis, in trichomatibus maturis haud visibilibus, in trichomatibus juvenibus supra subamplis ; cellulis perdurantibus sub-globosis, globosis, vel ellipticis, diametro duplo majoribus, plerumque singulis sed interdum bi vel triseriatis.

Frond small, about the size of a small pea, irregularly subglobose, soft, gelatinous, light green, not distinctly zoned ; filaments generally straightish, partly distinctly, partly indistinctly articulate ; sheaths in the mature filament not perceptible ; in the young filaments rather large in the upper portion ; heterocysts subglobose or globose or elliptic, twice as large as the filament, generally single but sometimes bi or tri-seriate.

Diam. trich. $\frac{1}{3000}''$–$\frac{1}{4500}''$; cell. perd. $\frac{1}{1800}''$.

Hab. In palude plantas aquaticas adhaerens, Northern Michigan.

GEN. MASTIGONEMA.

M. ELONGATUM. *Sp. Nov.*

M. initio subglobosum, postea saepe nonnihil fusinum, nigro-viride, lubricum, firme ; trichomatibus aerugineis, valde elongatis, flagelliformibus, interdum inarticulatis sed saepius breve articulatis, interdum ad genicula valde constrictis ; apice interdum truncato sed plerumque in pilo, longo, achroo, flexuoso, producto ; vaginis achrois, arctis, saepe apice truncatis ; cellulis perdurantibus globosis vel subglobosis.

Thallus at first subglobose, afterwards frequently fusiform, blackish green, slippery, firm; filaments aeruginous, very elongate, sometimes not articulated, but more generally shortly articulated, sometimes strongly contracted at the joints; apices sometimes truncate but generally produced into a long, flexuous, translucent hair; sheath transparent, close, frequently truncate at the apex; heterocysts globose or subglobose.

Diam. $\frac{2}{7500}''$=.00026.″

Hab. In aquario meo.

GEN. MASTIGOTHRIX.

M. FIBROSA. *Sp. Nov.*

M. trichomatibus dilute caeruleo-viridibus vel olivaceis vel subaerugineis, infra haud articulatis, supra saepe breve articulatis; apice in trichomatibus maturis in setam hyalinam, distincte articulatam, longam, producto; vaginis achrois, in filamentis immaturis, distale distinctis, latis, hyalinis, infra modice crassis, arctis—in trichomatibus maturis infra arctis, et indistinctis, supra in fibetillis dissolutis, in apice, absentibus; cellulis perdurantibus globosis interdum geminis.

Filament either light bluish green or olivaceous or subaeruginous, below not articulate, its upper portion often shortly articulate; apex produced in the mature filament into a hyaline seta, which is long and distinctly articulate; sheath transparent—in the immature filament, distally distinct, broad, hyaline, but proximally close and rather thick—in the mature filament below close and rather indistinct, and superiorly dissolved in fibrillae so as to be entirely wanting at the apex; heterocysts globose, sometimes in pairs.

Diam. trichom. $\frac{1}{2250}''$; cell. perdur. $\frac{7}{18000}''$–$\frac{4}{18000}''$.

Hab. In strato mucoso cum algis variis, in rupibus irroratis prope Philadelphia.

FAM. SCYTONEMEACEAE.

GEN. SCYTONEMA.

S. CATARACTA. *Sp. Nov.*

S. rupicola, caespitosum, fusco-atrum, longe et late expansum; trichomatibus flexuosis, flexilibus, fere 0.25″ longibus, vage pseudoramosissimis, superficie laeve; pseudoramis elongatis, singulis, rarissime geminis, liberis, interdum fuscis, saepius hyalinis, apice plerumque truncato, rare nonnihil attenuato, saepe barbato, haud rubello; trichomatibus internis aerugineis, tenuissimis, plerumque distincte articulatis; articulis diametro plerumque brevioribus, sed interdum longioribus, saepe sejunctis, saepe subglobosis; vaginis crassis et firmis; cellulis perdurantibus et basilaribus et interjectis, singulis, rarissime geminis.

Diam. trich. c. vag. plerumque .00045″; max. .0011″; sine vag. max. .00013.″

S. Forming on rocks an extended turf-like stratum of a brownish

black color; filaments flexuous, flexible, almost 0.25″ long, irregularly branched, their surface smooth; branches elongate, single, rarely in pairs, free, sometimes fuscous, frequently hyaline, their apices generally truncate, rarely somewhat attenuate, frequently provided with enlargements, never reddish; cytioplasm aeruginous, very thin, generally distinctly articulate; articles mostly shorter than broad, but sometimes longer, frequently disjoined, often subglobose; sheaths thick and firm; heterocysts both basal and interjected, single, extremely rarely geminate.

Hab. In flumine Niagara prope cataractam.

S. CORTEX. *Sp. Nov.*

S. minutissimum, stratum tenue submembraneum formante; trichomatibus sparse pseudoramulosis, pseudoramulisque repentibus et plus minus concretis, viridibus aut dilute fuscis, varie curvatis, haud rigidis; cytioplasmate viride, articulato, rare distincte granuloso; articulis diametro longioribus aut brevioribus; vaginis arctis, nonnihil tenuibus, achrois, plerumque coloris expertibus, sed interdum dilute fuscis; cellulis perdurantibus et singulis et geminis, et basalibus et interjectis, globosis vel subglobosis.

S. Very minute, forming a thin, submembranaceous stratum; filaments sparsely branched, together with the branches, creeping and more or less concreted together by their sides, green or light brown, variously curved, not rigid; cytioplasm (internal filament) articulate, rarely distinctly granulate; joints longer or shorter than broad; sheaths close, rather thin, transparent, generally colorless but sometimes light brown; heterocysts globular or subglobular, single or in pairs, basal or otherwise.

Diam. trich. cum vag. $\frac{2}{750}''-\frac{3}{750}''$.

Hab. South Carolina in ramis (Platanus occidentalis). Prof. Ravenel.

S. RAVENELLII.* *Sp. Nov.*

S. lignicola, breve caespitosum, viride-nigrum; trichomatibus plerumque repentibus, vel fusco-olivaceis vel aureo-fuscis, modice pseudoramosis; ramis ascendentibus, rigidis, flexuosis rare pseudoramulosis, vel fusco-olivaceis vel aureo-fuscis, rarissime cum apicibus subachrois; trichomatibus internis coloris expertibus, granulosis, saepe vagina erumpentibus, plerumque articulatis; articulis diametro longioribus aut brevioribus; vaginis arctis, crassibus, fusco-olivaceis vel aureo-fuscis, plerumque supra truncatis et apertis, superficie nonnunquam irregulare; cellulis perdurantibus subquadratis, singulis, interjectis.

S. Forming little, shortly turfy spots, on bark, of a greenish color; filaments mostly creeping, either brownish olive or yellowish brown, moderately branched; branches ascending, rigid, flexuous, very rarely provided with secondary branchlets, either brownish olive or yellowish

* It affords me great pleasure to dedicate this species to Prof. H. W. Ravenel as an acknowledgment, not so much of the aid rendered in my studies of our fresh water algae, as of his great services to science in some of her kindred branches.

brown, rarely subtransparent at the apex; cytioplasm colorless, granular, often extending out beyond the sheaths, generally articulate; joints longer or shorter than broad; sheaths close, thick, brownish olive or yellowish brown, for the most part truncate at their ends and open, their surface sometimes irregular; heterocysts subquadrate, single, interstitial.

Diam. trich. cum vag. $\frac{9}{7500}''$–$\frac{6}{7500}''$; ram. c. v. $\frac{4}{7500}''$–$\frac{6}{7500}''$.

Hab. South Carolina, in ramis Celtis. Prof. H. W. Ravenel.

GEN. SYMPHOSIPHON.

S. CORIACEA. *Sp. Nov.*

S. in strato ad 2 lineam crasso, coriaceo, nonnihil spongioso disposita; trichomatibus pseudoramulisque flexuosis, dense intricatis, arcte concretis; trichomatibus internis rarissime haud articulatis sed plerumque breve et distincte articulatis, plerumque pallescentibus, interdum dilutissime aerugineis, saepe interruptis; articulis granulosis, interdum sejunctis, diametro subaequalibus ad fere duplo longioribus; vaginis crassissimis, distincte lamellosis, achrois et coloris expertibus, stratis externis saepe intumescentibus, superficie corrugata, hirta; cellulis perdurantibus nullis?

S. Forming a leathery and spongy, tough stratum of about 2 lines in thickness and of a light slate color. Filaments and branches flexuous densely intricate, closely concreted; internal filament very rarely not articulated, in most cases very distinctly jointed, generally nearly colorless, sometimes with a faint aeruginous tint, often interrupted; articles granular, sometimes disjoined, from about equal to twice the length of their diameter; sheaths very thick, transparent and colorless, very distinctly lamellated, external lamella often swollen, their surface corrugate and variously rough and ragged; heterocysts none.?

Diam. trich. c. vag. max. $\frac{10}{12000}''$=.00083; sin. vag. max. $\frac{3}{12000}''$=.00025.

Remarks.—I have examined a great number of filaments and have nowhere seen anything like a heterocyst. The specimens examined had been preserved in solution of acetate of alumina, but I do not think the salt had changed materially their color.

Hab. Texas. Prof. Ravenel.

GEN. TOLYPOTHRIX.

T. DISTORTA. (*Müller.*) *Ktz. Var.?*

In aquario. Dr. Fricke.

Remarks.—The specimens which have been identified as T. distorta, agree well with the descriptions of that species, except in the fact that the heterocysts are often 4-seriate and that they are rather parallelogrammatic than subglobose, as well as in the circumstance that the sheaths are close. I do not think the differences are sufficient to distinguish species.

FAM. SIROSIPHONEACEAE.

GEN. SIROSIPHON.

S. PULVINATUS. *Breb.*

Hab. In rupibus irroratis prope Philadelphia.

S. GUTTULA. *Sp. Nov.*

S. in maculis subnigris, parvis, tenuibus, plerumque rotundatis, interdum enormibus, dispositum; trichomatibus arcte intertextis, ramossissimis, rigidis, inaequalibus, subcylindricis, nonnihil contortis; ramulis abbreviatis vel nonnihil elongatis, apice obtuse rotundatis; ramulorum et trichomatum cellulis tri-multiseriatis, plerumque pachydermaticis, ferrugineo-fuscis, enormiter globosis, homogeneis; cellulis apicalibus interdum breve cylindricis, haud articulatis; vaginis sat amplis, luteo-brunneis vel dilute ferrugineo-brunneis.

Arranged in small, thin black spots, which are generally round, but sometimes irregular: filaments closely interwoven, very much branched, rigid, unequal, subcylindrical, somewhat contorted; branches abbreviate or somewhat elongate, apex obtusely rounded; cells of the trichoma and branches 3 to many seriate, mostly with thick coats, ferruginous-fuscous, irregularly globose, homogeneous; apical cells sometimes shortly cylindrical, not articulate, sheaths ample, yellowish brown.

Diam. max. trich. cum vag. $\frac{1}{750}''$=.0013.

Hab. South Carolina, ad Taxodium distichon corticem. Prof. Ravenel.

S. ACERVATUS. *Sp. Nov.*

S. in guttulis minutissimis, subcrustaceis, nigris, in strato subcontinuo saepe aggregatis; trichomatibus parvis et brevibus, rigidis, admodum inaequalibus, prostratis, tuberculis, arcte et dense ramossissimis, viridibus aut aureis aut brunneis; ramulis brevibus, plerumque haud ramulosis, erectis aut ascendentibus, saepe abbreviatis, papilliformibus, obtusis, saepe lateraliter connatis; cellularum serie in trichomatibus multiplici in ramulis plerumque simplici; cellulis subglobosis vel subangularibus, viridibus, haud distincte granulosis, in ramulorum apice saepe breve cylindricis et interdum obsolete articulatis; vaginis aureis, nonnihil hyalinis.

Arranged in drops, which are very minute, subcrustaceous, black, and frequently aggregate into a subcontinuous stratum; filaments small and short, prostrate, rigid, somewhat unequal, tuberculate, densely and closely branched, green or golden or brown; branches short, for the most part not branched, erect or ascending, frequently abbreviate, papiliform, obtuse; series of cell multiple in trichoma, mostly simple in the branches; cells subglobose or subangular, green, not distinctly granulate, in the apices of the branches frequently shortly cylindrical and sometimes obsoletely articulate; sheaths golden, somewhat hyaline.

Hab. South Carolina, ad corticem (Ilex opaca). Prof. H. W. Ravenel.

Diam. trich. cum. vag. max. $\frac{1}{300}$ Ram. $\frac{3}{7500}$ - $\frac{4}{7500}$

Remarks.—This species is closely allied to S. coraloides, but I think is distinct from it.

S. LIGNICOLA. *Sp. Nov.*

S. strato expanso, tomentoso, atro; trichomatibus ramossissimis, arcte intertextis; ramulis abbreviatis vel elongatis, subrectis aut varie curvatis, apicibus obtuse rotundatis vel subacuminatis; trichomatum et ramulorum cellulis uni vel biseriatis, plerumque pachydermaticis, dilute vel saturate aerugineis, enormibus, plerumque homogeneis; cellulis terminalibus elongatis, cylindricis, saepius nonnihil oscillatorium modo articulatis, granulosis; vaginis sat amplis, haud achrois, vel luteo-brunneis vel fuscentibus vel ferrugineis.

Occurring in an expanded, tomentose, black stratum; filaments very much branched, closely interwoven, branches abbreviate or elongate, nearly straight or variously curved, their apices obtusely rounded or subacuminate; cells 1-2 seriate, mostly thick walled, light or deep aeruginous, irregular, mostly homogeneous; terminal cells elongate, cylindrical, frequently articulate somewhat like an oscillatoria, granulate; sheaths somewhat ample, not transparent, light brown, fuscous or ferruginous.

Diam. trich. cum vag. max. $\frac{1}{1500}''$=.00066″.

Hab. South Carolina; in lignis fabrefactis. Prof. H. W. Ravenel.

S. NEGLECTUS. *Sp. Nov.*

S. immersus; trichomatibus subsolitariis, longis usque ad lineas quatuor, cylindricis, ramossissimis; ramulis singulis; cytioplasmate interdum aerugineo, plerumque aureo-brunneo; cellulis uniseriatis rarissime biseriatis, subglobosis, interdum sejunctis sed plerumque arcte connectis et moniliformibus, modo confluentibus, haud distincte pachydermaticis; cellulis terminalibus elongato-cylindricis, saepe nonnihil oscilatorium modo articulatis; cellulis interstitialibus nullis; vaginis achrois, interdum brunneis, plerumque coloris expertibus.

S. immersed, subsolitary, attaining a length of 4 lines, cylindrical, very much branched; branches single; cytioplasm aeruginous, mostly yellowish brown; cells uniseriate, very rarely biseriate, subglobose, sometimes separate but more frequently closely united and moniliform; terminal cell an elongated cylinder, often articulate somewhat like an oscillatoria; interstitial cells wanting; sheaths transparent, sometimes brown, mostly colorless.

Remarks.—This species is perhaps too close to S. crameri, but appears to differ from it very markedly in habit and place of growth.

Diam. trich. cum. vag. $\frac{1}{570}$ = .0017; sine. vag. $\frac{1}{1000}''$

Hab. In stagnis prope Camden, New Jersey.

S. PELLUCIDULUS. *Sp Nov.*

S. immersus; trichomatibus ramossissimis, solitariis vel subsolitariis; ramis plerumque unilateralibus, ramulosis; ramulorum apicibus late rotundatis, haud attenuatis; cellulis in seriebus simplicibus dispositis, in

trichomatibus nonnihil rotundatis, in ramulis saepe angularibus, plerumque compressis, diametro aequalibus—4 plo brevioribus, terminalibus cylindricis, obscure articulatis; cellulis interstitialibus nullis; vaginis arctis, hyalinis, haud lamellosis; cytioplasmate aerugineo vel brunneo, minute granulato.

S. immersed; filaments very much branched, solitary or subsolitary; branches mostly unilateral, branched; apices of the branches not attenuate, broadly rounded; cells disposed in a simple series, in the trichoma somewhat rounded, in the branches frequently angular, mostly compressed, equal to 4 times shorter than the diameter; terminal cell cylindrical, obscurely articulate; interstitial cells none; sheath close, hyaline, not lamellate; cytioplasm aeruginous or brown, minutely granulate.

Diam. trich. cum vag. $\frac{8}{7500}''$=.00106″; sine vag. .0008″.

Hab. In stagnis, prope Hibernia Florida. Mr. Wm. Canby.

8. SCYTENEMATOIDES. *Sp. Nov.*

S. strato submembranaceo, nigro-viride, saepe interrupto, cum superficie inaequale; trichomatibus saepe arcte intricatis, flexuosis aut varie curvatis, haud rigidis, plerumque vix ramosis; cellulis uniseriatis, interdum interruptis, arctis, irregulare quadrangulis, diametro subaequalibus aut 1-3 plo brevioribus, haud distincte granulatis, caeruleo-viridibus; vaginis amplis, haud distincte lamellosis, superficie enormiter corrugatis et hirtis, achrois, plerumque coloris expertibus interdum dilute brunneis.

S. In a submembranaceous, blackish green, frequently interrupted stratum, with an uneven surface; filaments often closely intricate, flexuous or variously curved, not rigid, mostly sparsely branched; cells uniseriate, sometimes interrupted, close, irregularly quadrangular, about equal in length to their diameter, or about 1-3 times shorter, not distinctly granulate, bluish green; sheaths ample, not distinctly lamellate, their surface rough and corrugate, transparent, mostly colorless, sometimes light brown.

Diam. sine. vag. max. $\frac{5}{7500}''$=.00066″; cum vag. max. $\frac{10}{7500}''$=.0013″.

CLASS CHLOROPHYLLOPHYCEAE.

FAM. PALMELLACEAE.

GEN. PALMELLA.

P. JESENII. *Sp. Nov.*

P. thallo indefinite expanso, initio dilute aut laete viride, molle, pellucidulo; aetate provecta firmo, tuberculoso, saturate olivaceo-viride; cellulis globosis vel ellipticis,—in thalli aetate immaturo, plerumque singulis aut geminis, saepe distantibus,—in aetate provecta saepe in familias connexis, plerumque confertis; tegumentis in thalli aetate immaturo plerumque diffluentibus, aetate provecta plerumque distinctis.

Thallus indefinitely expanded, in the beginning soft and pellucid, after-

wards firm, tubercular, deep olive green: cells globose or elliptical; in the immature thallus, single or geminate, frequently scattered; in the mature thallus often closely conjoined into families, mostly crowded; in the young thallus the teguments of the cells are mostly diffluent, afterwards distinct.

Diam. cell. glob. max. $\frac{1}{3500}''$=.00028; cell. oblong. long. max. $\frac{1}{2500}''$ =.0004.

GEN. TETRASPORA.

T. LUBRICA. (*Roth*) *Ag.*

In aquis limpidis prope Philadelphia.

GEN. RHAPHIDIUM.

R. POLYMORPHUM. *Fresen.*

Hab. Prope Philadelphia.

FAM. PROTOCOCCACEAE.

GEN. SCÉNESDESMUS.

S. ACUTUS. *Meyen.*

Hab. Prope Philadelphia.

S. POLYMORPHUS. *Sp. Nov.*

S. cellulis fusiformibus, aut ovalibus aut ellipticis aut globosis, singulis aut 2-8 conjunctis, plerumque utroque polo aculeo unico, interdum aculeis duobus, instructis: apicibus obtusis, acutis, vel acutissimis; aculeis gracillimis, rectis, modice elongatis, inclinatis.

S. cells fusiform, or oval, or elliptic, or globose, single or 2-7 conjoined, furnished in most cases with a single spine, sometimes 2, at each end; ends obtuse, acute or very acute; spines exceedingly slender and acute, straight, moderately long, inclined.

Diam. $\frac{1}{2500}''$–$\frac{1}{7500}''$; plerumque $\frac{1}{4000}''$.

Hab. In aquis quietis prope Camden, New Jersey.

GEN. HYDRODICTYION.

H. UTRICULATUM. *Roth.*

Hab. In stagnis prope Philadelphia.

GEN. PEDIASTRUM.

B. BORYANUM. (*Turpin.*) *Mengh.*

Hab. In stagnis prope Philadelphia.

FAM. DESMIDIEAE.*

GEN. PALMOGLOEA.

P. CLEPSYDRA. *Wood.*

P. saxicola et bryophila, in gelatina achroa interdum dilute viride nidulans; cellulis cylindricis, cum polis obtuse truncato-rotundatis, diametro 2-3 plo longioribus; lamina chlorophyllacea axili, plerumque indistincte, saepe nulla; plasmate dilute viride; nucleo plerumque distincto; zygosporis subfuscis aut subglobosis aut enormiter in clepsydræ forma; membrana externa enormiter excavata et sulcata.

P. living on rocks and mosses, swimming in a transparent, sometimes light green jelly; cells obtusely truncated, rounded at the ends, 2-3 times longer than broad; chlorophyll lamina axillary, mostly indistinct, often wanting; endochrome light green; nucleus generally distinct; zygospore subfuscous, either subglobose or of an irregular form, somewhat resembling that of an hour-glass; external coat irregularly excavated and sulcate.

Diam. $\frac{13}{7500}''$.

Hab. In rupibus et in muscis irroratis ad Chelten Hills, prope Philadelphia.

GEN. CLOSTERIUM.

C. EHRENBERGII. *Menegh.*

Hab. Prope Philadelphia.

C. DIANAE. *Ehrb.*

Hab. Prope Philadelphia.

C. LUNULA.

Hab. Prope Philadelphia.

C. ROSTRATUM. *Ehrb.*

Hab. Prope Philadelphia,

C. SETACEUM. *Ehrb.*

Hab. Prope Philadelphia.

C. LINEATUM. *Ehrb.*

Hab. Prope Philadelphia.

C. LEIBLEINII. *Ktz.*

Hab. Prope Philadelphia.

C. PARVULUM. *Naeg.*

Hab. Prope Philadelphia.

C. ACEROSUM. (Schrank.) *Ehrb.*

Hab. Prope Philadelphia.

* I have paid so little attention to the Desmids that I intended at first to omit the family, but afterwards thought best to mention the few I have identified.

GEN. TETMEMORUS.

T. GRANULATUS. (*Bréb.*) *Ralfs.*

Hab. Prope Philadelphia.

GEN. PLEUROTAENIUM.

P. TRABECULA. (*Ehrb.*) *Naeg.*

Hab. Prope Philadelphia.

GEN. SPIROTAENIA.

S. BRYOPHILA. (*Bréb.*) *Rabenhorst.*

Hab. Prope Philadelphia.

GEN. MICRASTERIAS.

M. TRUNCATA. (*Corda.*) *Brib.*

Hab. Prope Philadelphia.

M. JENNERI. *Ralfs.*

GEN. STAURASTRUM.

S. PUNCTUALATUM. *Bréb.*

Hab. Prope Philadelphia.

GEN. DIDYMOPRIUM.

DR. GREVILII. *Ktz.*

Hab. Prope Philadelphia.

GEN. COSMARIUM.

C. CUCUMIS.

Hab. Prope Philadelphia.

C. BOTRYTIS. (*Bory.*) *Menegh.*

Hab. Prope Philadelphia.

FAM. ZYGNEMACEAE.

Remarks.—In this family I only enumerate such species as I have found in fruit, since there can be no certain identification of sterile plants. My list I am well satisfied, however, by no means completely represents the fauna of the neighborhood of Philadelphia.

GEN. RHYNCONEMA.

R. ELONGATA, *Sp. Nov.*

R. articulis vegetativis diametro 7-20 plo longioribus; articulis sporiferis multo brevioribus, valde tumidis; cytiodermate utroque fine protense et replicato; fascia unica, laxissime spirali; anfractibus plerumque 7; sporis ellipticis, diametro 1-2½ plo longioribus.

Sterile joints 7-20 times longer than broad; fertile joints much

shorter, greatly swollen; cell wall at each end produced or folded in; chlorophyll filament 1, spiral lax; turns mostly 7; spores elliptical, 2-2½ times longer than broad.

Diam. Spor. $\frac{8}{7500}$ = .00106. Artic. vegetat. $\frac{4}{7500}$ .0005.

Hab. In aquis limpidis prope Philadelphia.

R. PULCHELLA. *Sp. Nov.*

R. articulis sterilibus diametro 2-3 plo longioribus; sporiferis nonnihil tumidis; fascia unica; anfractibus 3-4; sporis ellipticis, diametro fere duplo longioribus; cytiodermate utroque fine protense et replicato.

Sterile joints 2-3 times longer than broad; fertile joints somewhat swollen; chlorophyll band one; turns of spiral 3-4; spores elliptical, almost twice as long as broad; cell wall at each end produced or folded in.

Diam. Artic. Steril. $\frac{4}{7500}$ – $\frac{9}{7500}$ = .00033 – .0013. Spar. $\frac{9}{7500}$ – $\frac{10}{7500}$ = .0012 .00133.

Hab. In stagnis prope Philadelphia.

GEN. SPIROGYRA.

S. WEBERI. *Ktz.*

Remarks.—The American form agrees pretty well with the European, but is however, larger, its cells also a attain a greater proportionate length, and their chlorophyll bands have more turns. The lower limits of the American form are, however, so overlapped by the upper limits of the European, that it seems to me they must be considered identical.

Hab. In stagnis prope Philadelphia.

S. DUBIA. *Ktz.*

Remarks.—I have never seen the sporangial cell swollen in American specimens, in other respects the agreement is complete.

Hab. In stagnis prope Philadelphia.

S. QUININA. (*Ag*) *Ktz.*

Hab. In stagnis prope Philadelphia.

S. RIVULARIS. (Hassall), *Rabenhorst.*

Hab. In rivulis prope Hibernia, Florida. Mr. Wm. Canby.

S. LONGATA. (*Vauch*), *Ktz.*

Hab. In stagnis prope Philadelphia.

S. INSIGNIS. (*Hassall*), *Ktz.*

Hab. In stagnis prope Philadelphia.

S. PROTECTA. *Sp. Nov.*

S. saturate viridis, lubrica; articulis sterilibus diametro 6 plo longioribus; sporiferis vix tumidis; cytiodermate in cellulæ utroque fine protense et replicato; fascia unica; anfractibus 6; sporis oblongis vel ellipticis: membrano crassissimo.

S. Deep green, slippery; sterile joints 6 times longer than broad; fer-

tile cells scarcely swollen; cell wall folded in at the ends; chlorophyll band single; turns 6; spores oblong or elliptical, spore wall very thick.

Diam. Art. steril. $\frac{11}{500}''$=.00146; spor. lat. $\frac{10}{500}''$–$\frac{13}{500}''$=.00133–.0016 long. $\frac{25}{500}$=0033.

S. CRASSA. *Ktz.*

Hab. In stagnis prope Philadelphia.

S. DILUTA. *Sp. Nov.*

S. articulis sterilibus diametro subæqualibus ad duplo longioribus; fructiferis haud tumidis; fasciis spiralibus 5, angustissimis, laxis, valde nodosis; anfractibus plerumque ½, interdum 1; zygosporis sparsis, late ellipticis vel ovatis aut globosis; cytiodermate modice teuue, in utroque fine nec protenso nec replicato.

S. Sterile joints about as long as broad to twice longer, fertile cells not swollen; chlorophyll bands 5, exceedingly narrow, lax, strongly nodose; turns mostly ½, sometimes 1; zygospores few, broadly elliptical, ovate or globose; cell wall moderately thin, not infolded at the ends.

Diam. Artic. steril. $\frac{23}{500}''$=.003″.

Hab. In stagnis prope Philadelphia.

S. PARVISPORA. *Sp. Nov.*

S. articulis sterilibus diametro 2-4 plo longioribus; fructiferis haud tumidis, diametro 1-2½ plo longioribus; fasciis spiralibus 4, angustis, nodosis, anfractibus pluribus; zygosporis parvissimis, ellipticis, diametro 1¼-2 plo longioribus; cytiodermate utroque fine nec protenso, nec replicato.

Sterile joints 2-4 times longer than broad; fertile not tumid, 1-2½ times longer than broad; chlorophyll bands 4, narrow, nodose; turns many; zygospores very small, elliptical, 1¼-2 times longer than broad; cell wall not infolded at the end.

Diam. Art. Steril $\frac{23}{500}''$=.003 spor. diam. transv. $\frac{15}{500}''$–$\frac{17}{500}''$=.002–0023; long $\frac{21}{500}''$–$\frac{30}{500}''$=

Hab. In stagnis, Hibernia, Florida. Mr. Wm. Canby.

GEN. ZYGNEMA.

Z. INSIGNIS. (*Hassall*), *Ktz.*

Hab. In stagnis prope Philadelphia.

GEN. SIROGONIUM.

S. RETROVERSUM. *Sp. Nov.*

S. articulis sterilibus diametro 7-15 plo longioribus; fasciis spiralibus 1, rare 2, latis, granulatis; anfractibus 1-9; articulis fertilibus valde tumidis, retroversis, copulatione genuflexa et sine tubo connexivo; cytiodermate nonnihil crasso, utroque fine protenso vel replicato; sporis ellipticis.

Sterile joints 7-15 times longer than broad; chloroplyll band 1, rarely 2, broad, granulate; turns 1-9; fertile article very tumid, retroverted;

union of cells without connecting tubes, genuflexuous; cytioderm somewhat thick, infolded at the ends; spores elliptical.

Diam. cell. steril. $\frac{9}{7500}''$=.0012.

GEN. MESOCARPUS.

M. SCALARIS. *Hassal.*

Hab. In stagnis prope Philadelphia.

ORD. SIPHOPHYCEAE.

FAM. HYDROGASTREÆ.

GEN. HYDROGASTRUM.

H. GRANULATUM. (*Linn*). *Disv.*

Hab. In stagnis exsiccatis, Delaware. Dr. I. F. Billings.

FAM. VAUCHERIACEÆ.

GEN. VAUCHERIA.

V. GEMINATA. (*Vauch*). *De C.*

Hab. In stagnis prope Philadelphia.

V. POLYMORPHA. *Sp. Nov.*

V. in cæspites dense intricata; thallo capillari, tenui; antheridia corniculata ex ramuli lateralis apice formatis; ramulis fertilibus interdum et oogoniis et antheridiis instructis, interdum antheridiis solum; oogoniis plerumque geminis, interdum singulis, globosis vel ovatis, sæpe brevirostratis, plerumque distincte pedunculatis sed rarius sessilibus; oosporis enormiter subglobosis vel ovatis; sporodermate achroo e stratis duobus composito.

Cæspitose; thallus hair like, thin; antheridia corniculate, formed of the apex of lateral branches; fertile branches sometimes furnished both with oogonia and antheridia, sometimes with antheridia alone; oogonia sometimes single but mostly in pairs, occasionally shortly rostrate, generally distinctly pedunculate but sometimes sessile; oospores irregularly subglobose or ovate, surrounded by a transparent double spore coat.

Hab. In aquis prope "Buffalo Bayou," Louisiana. Prof. H. W. Ravenel.

V. SERICEA. *Lyngb.*

Hab. In stagnis et humis irroratis prope Philadelphia.

V. AVERSA. *Hassal.*

Remarks.—I have found this species in the neighborhood of Philadelphia, if indeed it be a species. Prof. Rabenhorst thinks it probably merely a form of the preceeding and all the specimens I have seen appeared to run into it.

ORD. NEMATOPHYCEAE.

FAM. ULVACEAE.

GEN. SCHIZOMERIS.

S. LEIBLEINII. *Ktz.?*

See Proc. Biolog. and Microsc. Department, Ac. Nat. Sc. 1868, p. 12.

FAM. OEDOGONIACEAE.

O. MIRABILE. *Sp. Nov.*

O. gynandrum, rare setigerum; articulis diametro 2-8 plo longioribus; oogoniis plerumque singulis, rare geminis, nonnihil ovatis, infra latis sed supra contractis et medio tumidis; poris lateralibus duobus supra medium positis; oosporis aut late ovalibus aut subglobosis; sporodermate haud signato; antheridiis plerumque bicellularibus, interdum tricellularibus, plerumque in filo vegetativo infra oogonium aut in oogonio insidentibus; spermatozoideis singulis et geminis.

O. gynandrous, rarely setigerous; articles 2-8 times longer than broad; oosporangia mostly single, rarely geminate, subovate, in the lower portion broad, in the middle swollen, in upper part contracted; the 2 lateral pores situated above the middle; oospore subglobose or broadly ovate; it coats without markings; antheridia generally bicellular, sometimes tricellular, numerous, placed generally upon the female filament either upon or below the oosporangia.

Diam. Artic. veget. $\frac{3}{750}''-\frac{13}{750}''=.0004-0017$. Spor. $\frac{18}{750}''-\frac{20}{750}''=.0024''-0027''$.

H. ab. In rivulis quietis prope Philadelphia.

O. HUNTII. *Wood.* (*American Naturalist.*)

Hab. In aquario meo.

O. INEQUALE. *Sp. Nov.*

O. dioicum; cellula basali biloba; plantis femines quam plantis masculis permulto majoribus; oogoniis enormiter globosis vel subovoideis, poro laterale supra medium posito instructis; oosporis forma eadem, sed paulo minoribus.

O. dioecious, basal cell bilobate; feminine plant very much larger than the male plant; oosporangium irregularly globose or subovoidal, opening by a lateral pore above the middle; resting spores of the same form as the sporangium but a little smaller.

Hab. In stagnis prope Philadelphia.

O. MULTISPORUM. *Sp. Nov.*

O. gynandrum; oogoniis singulis, vel binis vel ternis continuis, globosis; pore laterale distale instructis; oosporis globosis, oogonii lumen replentibus; antheridiis plerumque pluribus planta feminea insidentibus, cellula inferiore multo majore.

O. gynandrous: oosporangia single or bi or triseriate, globose, about

the same size as the sporangial cavity; antheridia bi or tricellular, curved, with the lower cell much the largest, generally adhering in considerable numbers to all parts of the female plant.

Hab. In stagnis prope Philadelphia.

GENUS BULBOCHAETE.

B. CANBYII. *Sp. Nov.*

B. permagna ad .035″ longa, sparse ramosa; articulis sterilibus diametro 2-8 plo longioribus: oogoniis lateralibus vel in ramulorum apicem positis, transverse enormiter ovalibus; oosporis, transverse enormiter ovalibus, plerumque nonnihil triangularibus, oogonii lumen replentibus; sporodermate crasso, haud costato, enormiter punctato; antheridiis bicellularibus.

B. very large, attaining a length or more than one-third an inch, sparsely branched; sterile joints 2 to 8 times longer than broad; oosporangia lateral or placed upon the ends of branches, irregularly transversely oval; oospores of a similar shape often a little triangular, filling the cavity of the sporangium; spore coat thick, not costate but irregularly punctate.

Diam. cell. steril. $\frac{5}{7500}''-\frac{8}{6500}''$=.00066-001. Spor. transv. $\frac{17}{7500}''$=.00226.

Hab. In aquis quietis prope Hibernia, Florida, Mr. William Canby.

Remarks.—It affords me great pleasure to dedicate this very handsome species to Mr. William Canby, as an acknowledgment of favors received, and as a testimony of respect and high personal regard for him as a man, and as being among the foremost students of American phanerogamic botany.

B. DUMOSA. *Sp. Nov.*

B. articulis diametro 1½-2 plo longioribus; oogoniis plerumque in ramorum brevissimorum apicibus positis sed interdum lateralibus, plerumque setam terminalem gerentibus; oosporis enormiter ovalibus aut ovatis, nonnihil indistincte longitudinaliter oblique subarcte striatis; antheridiis bicellularibus, stipite instructis, cellula basale medio tumida, supra saepe contracta.

Joints 1½–2 times longer than broad: oosporangia generally placed upon the ends of short branches but sometimes lateral, mostly carrying a terminal seta; resting spores irregularly oval or ovate, somewhat indistinctly obliquely longitudinally and rather closely striate; antheridia bicellular, furnished with a little stipe, their basal cell tumid in the middle, frequently contracted above.

Hab. In aquario meo.

B. IGNOTA. *Sp. Nov.*

B. sparse ramosa, elongata; articulis diametro max. ($\frac{1}{1500}''$=.0066) 1½–2½ plo longioribus; oogoniis interdum lateralibus et sessibilius, interdum inter ramulorum cellulas vegetativas positis, dissepimento nullo; oosporis ovalibus, longitudinaliter nonnihil oblique et distante costatis, sporodermate nonnihil crasso; antheridiis 3-4 cellularibus, stipitatis.

B. sparsely branched, elongate with the joints 1½–2½ times longer than broad ($\frac{1}{150}''$=.0066); oosporangia sometimes lateral and sessile, sometimes placed upon the apex of a branch, sometimes situated in the length of the branches between their cells; the empty cell which supports them without dissepiment; oospores oval, filling closely the cavity of the spore case, longitudinally somewhat obliquely and distantly costate; spore coat rather thick; antheridia 3–4 celled, scarcely stipate.

Hab. In aquis quietis prope Philadelphia.

FAM. CHAETOPHORACEAE.

GEN. CHAETOPHORA.

C. PISIFORMIS (*Roth*) *Ag.*

Hab. In stagnis plantas, &c., adhaereus prope Philadelphia.

GEN. DRAPARNALDIA.

D. PLUMOSA. (*Vauch.*) *Ag.*

Hab. In aquis quietis prope Philadelphia.

D. GLOMERATA. (*Vauch.*) *Ag.*

Hab. In rivulis et stagnis et aquis limpidis quietis prope Philadelphia.

D. BILLINGSII. *Sp. Nov.*

D. valde gelatinosa; filis et ramis primariis achrois ad $\frac{30}{150}''$ crassis, sparsissime ramosis, articulis diametro 2-6 plo longioribus, saepe medio valde tumidis; fasciis chlorophyllis dilute viridibus, saepe nullis aut subnullis; ramulorum fasciculis distantibus, late ovalibus vel late triangularibus, alternantibus vel oppositis vel triplo verticellatis, sparse ramosis, patentissimis; ramulis cum pila longissima robusta terminale; oosporis globosis, moniliforme conjunctis; sporodermate crasso.

Frond very gelatinous, filament and primary branches attaining a diameter of $\frac{1}{250}''$, very sparsely branched, their articles 2-6 times longer than broad, often very much swollen in the middle; chrorophyll band light green, frequently almost or entirely wanting; fascicles of branches distant, broadly oval or triangular, alternate, opposite or in whorls of three, very open; ultimate branchlets terminating in a long, robust, hyaline hair; resting spores globose, with thick walls, arranged in long moniliform sometimes branched filaments.

Remarks.—I dedicate this very beautiful species to Dr. J. S. Billings, U. S. A., to whom I am under the greatest obligations for aid in the prosecution of this research, and whom I have ever found to unite the greatest scientific liberality to a strong enthusiasm for and able prosecution of the study of these lower vegetable forms.

Hab. In aquis limpidis quietis prope Philadelphia.

GEN. APHANOCHAETE.

A. REPENS. *A. Braun.*

Hab. In algiis confervaceis prope Philadelphia.

CLASS RHODOPHYCEAE.

FAM. PORPHYRACEAE.

GEN. PORPHYRIDIUM.

P. CRUENTUM. (*Ag*) *Naeg.*

Remarks.—A small piece of bone was sent me by my friend, Dr. Billings, on which were a few specks of this little organism. The bone had been picked up on Governor's Island, New York Harbor, and it is very possible that it was a fresh arrival from Europe. I have never met with traces of the species elsewhere.

P. MAGNIFICUM. *Sp. Nov.*

P. cellulis globosis vel subglobosis, rare nonnihil polygonis; cytioplasmate purpureo, granulato; cytiodermate crasso, haud lamelloso.

Cells globose or subglobose, rarely somewhat polygonal; endochrome purple, granulate; cell wall thick, not laminate.

Dram. Cell cum. tegum. $\frac{8}{24000}$–$\frac{13}{24000}$. Tegum. $\frac{1}{30000}$–$\frac{1}{18000}$.

Hab. In terra humida, Texas. Prof. Ravenel.

FAM. CHANTRANSIACEAE.

GEN. CHANTRANSIA.

C. EXPANSA. *Sp. Nov.*

C. caespitosa, in lapide stratum saturate violaceo-purpureum lubricum, indefinite expansum formans; filis purpureis, modice ramosis, fere 2 lineas longis et ramis plerumque strictis et rectis, saepe elongatis; ramulis fertilibus brevibus, ascendentibus; articulis diametro 3-8 plo longioribus, extremis obtusis; polysporis in ramellis lateralibus racemosim et confertim cumulatis, ovalibus vel nonnihil obovatis.

Caespitose, forming a dark purple, slippery, indefinite stratum on stones; filaments purple, moderately branched, almost 2 lines long, together with the branches strict and straight, often elongate; infertile branches sometimes very few, sometimes very numerous; fertile branches short, ascending; joints 3-8 times as long as their diameter, the final articles obtusely rounded: polyspores racemose, crowded on the fertile branches, oval or somewhat ovate.

Diam. Fil. $\frac{1}{2500}''$=.0004″, Spor. transv. $\frac{1}{3650}''$=.00027 long. $\frac{1}{2500}$= .0004″

Remarks.—I formerly referred this species very doubtfully to C. violacea Ktz., but am now convinced that it is distinct. Its size, mode of growth, and habit all are very different from those of that species.

Hab. In rivulis prope Philadelphia.

Whilst the above has been going through the press I have found floating on a "brick pond" the following new nostochaceous plant.

ANABAENA GIGANTEA. *Sp. Nov.*

A. thallo nullo, trichomatibus singulis et numeroso-consociatis, natantibus, rectis, in aetate juveni spiraliter convolutis; articulis plerumque subglobosis, arcte connexis, granulosis; cellulis perdurantibus interjectis, articulis vegetativis subaequalibus utroque polo punctiforme incrassatis, subsphaericis; sporis subsphaericis.

Thallus wanting; filaments occurring floating singly on water or in great numbers, straight, but in the young state often spirally convolnte; articles mostly subglobose, closely connected, granular, heterocysts subsphaerical, interstitial, a very little larger than the vegetative cells, thickened at each end in a punctiform manner; spore subsphaerical.

Diam. Artic vegetat. max $\frac{11}{24000}$=——— Heterocysts $\frac{1}{2000}$=.0005. Spor. at. $\frac{11}{12000}$=———Long. $\frac{1}{1000}$=.001.

Remarks.—With the above anabaena was a Caelosphaerium, which appears to be the *C. dubium Grun.* In no instance, however, was the frond of nearly so great size as the European form is said to attain to.

I have also recently identified the following plants, new to this continent.

GEN. CLADOPHORA.

C. BRACHYSTELECHA. *Rabenh.*

Hab. In aquis prope Philadelphia.

C. FRACTA. *Dillw.*

Hab. In flumine Schuylkill.

Stated Meeting, July 16, 1869.

Present, eight members.

Mr. FRALEY, Vice-President, in the Chair.

A letter accepting membership was received from John Phillips, dated Oxford, England, June 12, 1869.

A photograph for the Album was received from J. H. C. Coffin, of the National Observatory, Washington, D. C.

Letters of invoice and acknowledgment were received from the Royal Library at Munich, the Royal Academies at Pesth and Brussels, and from Mr. S. A. Green, Librarian of the Massachusetts Historical Society.

A letter was received from Gen. Humphreys, in reply to

the communication of the Secretaries respecting the publication of geological surveys in the West.

Donations for the Library were received from the Royal Societies and Academies of Tasmania, Hungary, Prussia, Bavaria and Belgium, the Societies at Moscow, Görlitz, Bremen, Penzance and Liverpool, the Observatories at Munich, Brussels, Washington and Cincinnati, the Geological Societies at Berlin and London, the Geographical Societies at Paris and London, M. Barrande, M. Zantedeschi, the Astronomical and Meteorological Societies at London, the Boston Public Library, Massachusetts Historical Society, Peabody Museum and Harvard College, the Franklin Institute, the Peabody Institute, the Bureau of Refugees and War Office at Washington, and the Wisconsin Historical Society. A large number of Educational volumes and pamphlets were received in exchange from the Massachusetts Historical Society.

The report of the Committee on Dr. Horn's paper was read and accepted, and the paper referred to the Publication Committee, with instructions to publish in the Transactions.

The death of Dr. C. D. Meigs, at his residence in Media, Pa., June 28, in the 78th year of his age, was announced by Dr. Rushenberger, and on motion the President of the Society was requested to nominate a member to prepare an obituary notice of the deceased.

Prof. Cope exhibited drawings of the fossil remains of a large Cretaceous Mosasauroid. He offered also for the acceptance of the Society six 8vo lithographic plates already prepared on stone to illustrate two papers of fossils found in Virginian caves. On motion the plates were accepted, and the Secretataries directed to have the requisite number of impressions taken to illustrate the two papers, for the next number of the Proceedings.

On motion the balloting for nominations 626—637 was postponed until October, on account of the small number of members present.

Pending nominations 638, 639, 640 were read, and the Society was adjourned.

SEVENTH CONTRIBUTION TO THE HERPETOLOGY OF TROPICAL AMERICA.

By Edward D. Cope.

[*Read before the American Philosophical Society, July 16, 1869.*]

Hydromedusa tectifera, *Cope, sp. nov.*

Char. The anterior portion of the carapace depressed and prolonged; the first vertebral scutum nearly twice as long as wide; the nuchal scutum narrow transverse, twice as wide as the first vertebral; four times as wide as long. Light brown, with slightly radiating or transverse darker brown spots on the costal plates. Below bright yellow.

Description. Carapace more elevated at the anterior vertebral bone than above the pelvis, then descending steeply, and prolonged roof-like to the nuchal margin. Posteriorly rather abruptly decurved to opposite the lowest plane of the sternum, and considerably below the strongly recurved points of the posterior lobe of the same. Two posterior vertebrals and each posterior costal with a projection at the posterior part. Margin a little elevated and turned out above the hinder limbs. The sides descend steeply, and the superior plane is broad outside of the scapulæ. Lateral marginals not prominent, being a ridge directed rather upwards, which is bounded above by a strong groove. Fine median marginals not united to disc throughout, but by costal processes. The first three marginal bones very much wider than long, the second nearly twice as wide. The nuchal marginal very large, as long as wide. Three marginal bones of the bridge with an undulate ridge along their upper margin, the third with the ridge running diagonally across it, descending behind.

Two last pairs of costal bones united on the median line. Last vertebral scutum of an urceolate form, much narrower at its point of contact with the penultimate. The latter the narrowest of the series. Penultimate marginal scutum extending nearly to the middle of the last vertebral. Second marginal scutum much longer than wide, the first, twice as long as wide. First costal longer than wide.

Sternum without fontanelle or intersternal elements, the anterior lobe both longer and wider than the posterior. The gular scuta small, the humeral and femoral each considerably wider than the pectoral. No axillary or inguinal plates, bridge short; claws strong. Posterior lobes with a deep rounded emargination.

Measurements.

	In.	Lin.
Length carapace (over arch)	11	4
Depth	3	1
Length sternum	8	4
Total width below	6	2
Length bridge	1	8
" femur (straight)	2	4
" tibia	2	5
" foot		23

Upper surface of limbs dark brown.

Habitat. This turtle occurs in some of the tributaries of the Parana or Uraguay rivers, either in the Argentine Confederation or the Banda Oriental, but in which, I do not know. My information is derived from W. W. Morgan, M. D., of Philadelphia, who resided many years in Monte Video, where he obtained the specimen from a collector.

This species differs from those already known, in the greater extension forwards and laterally of the anterior margin of the carapace. In consequence the forms of the vertebral, nuchal, and marginal plates are exaggerated in form, the first in length, the last two in width.

CHELOPUS RUBIDUS, *Cope.*

If this genus be regarded as co-extensive with the *Geoclemmys* of Dr. Gray, it embraces with the present addition, fourteen species.

Carapace oval, moderately elevated and with obtuse median keel; margin entire not recurved. Vertebral plates broader than long, with concave posterior sutures, except the anterior, in which the length is somewhat in excess. Its lateral margins are parallel and the anterior angle is produced, curtailing the small nuchal. Scuta concentrically grooved, visible, though obsolete in the old individual. Plastron rather plane, deeply emarginate behind; very openly in front. Inguinal and axillary scales very small. Areolæ of the scuta a little above and behind their centres.

Claws short, toes much united on all the limbs. Soles and palms with large scales. Forearm with six cross-rows of large scales in front, and two longitudinal rows on the outer side. A cross series of three across the carpus behind. Posterior foot club-shaped. Testudo-like, the heel with three cross rows of shields of 1, 3, 2 respectively, the posterior of the last two very large, double the next smallest. Rest of the hind limb small scaled.

Head broad plane above, muzzle and loreal region vertical. Beak obtusely hooked, not emarginate; alveolar faces without grooves or ridges.

Ground color of body yellow, the limbs and throat shaded and spotted with red, which is margined with black. The neck above and laterally is marked with numerous black rings and lines; below with the gular region it is closely black dotted. Tail very short, even in the males, yellow, with fine black longitudinal lines above. Limbs with black and pink dots. A chevron shaped red band extends from the orbits round the canthus nostralis and muzzle, and another wider and with narrow black margin between the orbits, with the apex forwards. Two similar bands extend from the orbits posteriorly to the obscure tympanum, and two are concentricably arranged on the occiput, the apex of the anterior being separated as a large red spot. In the male the colors are deeper and brighter. Carapace yellowish brown, each costal scutum with a horizontally oval black-edged yellow spot in its area, surrounded by yellow annuli. The young shows shows that there are two such concentric annuli. Marginals with alternating longitudinal yellow and black lines above, brown below. In the young, the vertebrals have a marginal yellow anuulus, and median oval ring with yellow and black variations.

Below, deep brown, the plastron broadly yellow all round. In the young the yellow extends over the whole plastron; in the very old the brown is very narrow medially.

Measurements, (No. 265.)

Greatest length plastron	Cm.	.1525
Width medially (Total)	"	.1123
Greatest length carapace	"	.16
Greatest elevation carapace	"	.064
Hind limb from knee	"	.0538
Fore " elbow	"	.041
Head and neck above	"	.07
Width head (Temporal)	"	.024
From orbit to end muzzle	"	.0082

Habitat. Tuchitan Tehuantepec, Mexico, discovered by Prof. Francis Sumichrast. Four specimens, Nos. 264–5–6–7.

This handsome land tortoise appears to approach sufficiently near the C. callicephalus, Gray (Proc. Zool. Soc., London, 1863, 254), of unknown habitat, to render a comparison proper. That species according to Gray, has a posteriorly truncate plastron, and a notched beak. The vertebral scuta are as long as broad, the second and third longer. The chin, throat, and upper parts of the neck are spotless. We owe this species to our active correspondent, F. Sumichrast, who since the days of Natterer, has not been equalled in the thoroughness and extent of his zoological researches in Tropical America.

CONIOPHANES PICEIVITTIS, *Cope.*

Scales in twenty-five longitudinal series, vertex and muzzle in one plane; upper part of rostral plate prominent, not produced between the internasals. Latter less than half prefrontals. Prefrontals longer than wide, decurved to the subquadrate loreal. Postnasal higher than prenasal. Preoculars one or two, postoculars two, superior larger. Superciliaries narrow. Frontal rather wide, with long posterior angle, and parallel lateral outlines which are little shorter than the anterior. Occipitals elongate, scarcely emarginate behind. Superior labials eight, fourth and fifth entering orbit. Sixth higher than long; seventh largest. Temporals 1–2. Postgeneials shorter than pregeneials. Inferior labials ten. Gastrosteges 158 two anals; urosteges, 90. Total length, .542 m.; of tail, .063 m.; from muzzle to canthus oris, .014 m.; interorbital width, .0048 m.

The ground color above and below is white, which is immaculate below, except on the throat and chin, where it is black dusted. Above three broad black bands extend from the end of the muzzle to the end of the tail. The inferior commences on the middle of the third row, and occupies three and two half rows of scales; a row and one-half intervenes between this and a median dorsal band which covers six and one or two half rows. The ground color on the head is an irregular line from the muzzle along each canthus and beyond orbit, and the upper labial plates; these are thickly dusted with black, the anterior spotted on the edge.

From Chihuitan, Tehuantepec, Western Mexico. F. Sumichrast, Coll. in Mus. Smithsonian, No. 248.

SYMPHIMUS LEUCOSTOMUS, *Cope, sp. et gen. nov.*

Char. gen. Dentition isodont; cephalic plates normal except that the internasals are confluent with the nasal, and the latter with each other and with the loreal. Preorbitals one. Rostral shield not prominent; scales smooth, equal, uniporous; anal bifid. General form elongate.

This genus differs from Chilomeniscus, to which its technical characters are similar, about as much as any colubrine serpent does from a burrowing calamarian. Its form is nearly that of Cyclophis, and it should perhaps be placed nearest to it in the system. Steindachner's *Bergenia mexicana** should, it appears to me, be referred to Chilomeniscus Cope, of which it is the fourth species.

Char. specif. The head narrow, not very distinct, the muzzle acuminate, but obtuse at the extremity. The scales in fifteen longitudinal series. The form is cylindric and elongate. The tail of medium length as in Cyclophis. Rostral plate high as wide, scarcely visible from above, not prominent. Side shield of the muzzle pierced by the nostril and extending to the preocular; latter long as high, not reaching the frontal. Postoculars one on one side, two on the other. Superior labials seven, third and fourth bounding orbit, all longer than high except the fifth; temporals 1–2 large, the anterior bounding the fifth and sixth labials. The median sutures of the rostronasal and prefrontal plates of equal length. Frontal longer than wide, with concave sides; superciliaries wide, occipitals elongate, common suture nearly as long as prefrontals and frontals together, truncate behind. Inferior labials eight, fifth largest—narrow; pregeneials a little longer than postgeneials. The eye is rather small. Urosteges, 111, gastrosteges.

Color olive gray above, a dorsal band of light brown extending over three rows of scales to the origin of the tail; the skin of its median region being yellow. Throat, chin and superior labials light yellow, a black line above the superior labials from the second posteriorly. The brown of the upper regions descends to the lower row of scales at about the twelfth transverse row; two or three lower rows are pale edged. Belly dirty white. The dorsal band is posteriorly ill defined, and extends a little beyond the vent; tail brown.

	In.	Lin.
Total length, No. 240	31	5.5
Length tail	10	9
Length rictus, No. 227		6.8
Interorbital width		2.8
Width muzzle		1.8
Width orbit		1.4
Length tail	7	0

No. 240. From Chihuitan, from the same.

No. 227. From the collections of the Smithsonian Institution from the province of Oaxaca, Mexico, made by Francis Sumichrast.

* Reised. Oester. Freg. Novara Reptilia, 92 fig.

LEPTODIRA MYSTACINA, *Cope.*

Scales in nineteen longitudinal series. Body very slightly compressed, head distinct, an elongate oval. Superior labials seven, the second in contact with the upper and lower preoculars, third and fourth with orbit, and fifth with occipital excluding the temporal. Fourth, fifth, and sixth higher than long; temporals 1-1-2. Oculars 2-2, inferior small in both sets. Internasals long as wide, prefrontals longer than wide. Frontal longer than wide, with parallel sides, considerably in contact with superior ocular. Occipitals oval, scarcely emarginate behind. Postgenеials longer than than pregenеials. Gastrosteges 187, anal 1-1, urosteges 70.

The ground color is a dirty white, and is uniform below. Above it, marked by very broad cross-bands, which extend to the gastrosteges and are twice as wide as the intervals of ground. There are thirteen to the vent; on the posterior half of the body they divide on the vertebral line, and alternate; one is thus continuous with two of an opposite side, leaving the ground in lateral squares. Head above, including occipitals, a lighter speckled brown above, leaving a white collar. A black band from eye to angle of mouth, and a second from below the eye to mouth, parallel to the above, encloses with it a light band; a black band from eye to nostril; lips in front black spotted. Total length 16.25 inches; of mouth 7 lines; of tail 4.25.

Habitat. The western region of Mexico, near the Isthmus of Tehuantepec, two specimens (251-261) sent to the Smithsonian Institution by Francis Sumichrast. This serpent approaches very near the L. pacifica Cope in details, but differs totally in coloration. The structural differences are the following:

L. mystacina.	*L. pacifica.*
Head elongate oval;	Head short wide.
Preocular reaching frontal;	Preocular not reaching.
Prefrontals longer than wide;	P. f. wider than long.
Fifth labial to occipital;	Fifth labial not to occipital.

TRIMORPHODON, *Cope.*

Proceed. Acad. Nat. Sci., Phila., 1861, 297.

This peculiar genus, hitherto not found outside of the Mexican, Central-American and Sonoran districts, is well illustrated by the collections received by the Smithsonian Institution. Two species have been hitherto known, and I now add three others, as follows:

I. Scales in 21-3 Rows.

Seven (six) superior labials; three loreals; head black in front with a white T shaped mark; back with uniform black rhombs.

T. TAU.

Eight superior labials; head broad, short; three loreals; head dark-brown, with light cross-bar on muzzle and between eyes, and V on occiput; body with broad brown annuli; tail one-fifth the total.

T. UPSILON.

Nine superior labials; head long, swollen behind; two loreals; head with a lyre-shaped pattern, back with irregular rhombs, with pale centres; tail one-sixth the length. T. LYROPHANES.

Nine superior labials; head long; two loreals; head with chevron bands; body with irregular pale centred rhombs.

T. BISCUTATUS.

Scales in 27 Rows.

Nine superior labials, three loreals; head elongate; two dark cross-bands and two chevrons on head; back with very irregular rhombs, with pale centres; tail one-sixth. T. MAJOR.

TRIMORPHODON TAU, *Cope.*

Scales in twenty-three series. Muzzle projecting considerably beyond the mouth. Rostral plate somewhat produced behind; internasals, about one-fourth size of prefrontals, which are long as wide. Frontal with straight lateral margins, which are longer than anterior. Occipital not longer than frontal, regularly rounded behind. Nostril in middle of nasal. Three loreals, three post and three preoculars. Temporals, 2–3–4. Superior labials six, the fifth probably composed of two plates fused, as it is twice as long as deep, on both sides. The fourth and fifth enter the orbit, the third is cut down by the lower loreal and preocular. Inferior labials, eleven. Body strongly compressed. Total length 0m. 236; of tail, .035 m.

Above gray, with twenty-three jet-black rhombs, which extend to the gastrosteges by their lateral angles. Tail with ten rhombs; all everywhere unspotted with paler. Sides of belly black spotted. Head gray with a black mask above as far as the middle of the occipitals, but with two lateral ear-shaped prolongations on the same; a pale T-shaped mark extends transversely between orbits, and longitudinally to end of muzzle.

One specimen, No. 236, from F. Sumichrast, from the western part of the Isthmus of Tehuantepec, Mexico.

TRIMOPHORDON UPSILON, *Cope.*

Internasals broader than long, prefrontal broad as long, frontal with parallel outline not reached by the preocular. Oculars 3-3. Nasals distinct, loreals three, forming an L. Temporals 3-3-3. Fourth and fifth labials in contact with orbits. Twelve inferior labials. Scales in 2-3 series. Body with twenty-four brown annuli, which are broken into irregular spots on the belly, and are broader than long on the vertebral line. On all but the anterior third the length, a vertical brown bar stands between these on the sides. Chin and lips white, superior plates brown spotted above. Loreal region spotted. Temporal and occipital region brown with a pale Y on the occipital common suture. Total length 0.34 m. Tail .052 m.; head to aictus .011 m.

One specimen in Mus. Smithsonian from I. I. Major, from Guadalaxara, West Mexico.

TRIMORPHODON MAJOR, *Cope.*

This large species has a head of lanceolate form; the body is compressed and the tail slender. The large number of series of scales characterizes it most distinctly. Gastrosteges 258, anal 1-1, urosteges 88. The preocular does not reach the frontal; temporals 3-4-5. There is a broad brown band across the muzzle and chevron, ceasing between the eyes, whose limbs are lost above the rictus ovis. A second chevron behind this is closed by a spot connecting the limbs behind. The dorsal rhombs extend to the gastrosteges, and are manifestly formed by the union of four spots, two vertebral, and one on each side; they enclose three spots of the ground in a cross-row.

Two specimens from near Tehuantepec from Francis Sumichrast.

TELEOLEPIS STRIATICEPS, *Cope, sp. et gen. nov.*

Character genericus. Dentition diacranterian. Cephalic shields normal; two nasals, the nostril in the anterior one; the loreal region with a deep longitudinal groove. Scales equal, smooth, biporous; anal shield entire. Tail short, body slender; head wide, very distinct.

Disregarding the scale pores, this form might be regarded as a near ally of Xenodon, or perhaps of Opheomorphus, for it has the head of the first and the body of the last. The importance of Reinhardt's scale pores I have often had occasion to observe, and I believe their absence or single or double existence to be as important indices of natural groups as any other structural feature. In general, Reinhardt's tables show that subterranean and aquatic Colubrine serpents do not possess these pores, while the more highly developed and typical forms of a more aerial life possess them double; the Coronelline forms of an intermediate character, possess single pores, though frequently none, and rarely two.

Teleolepis agrees with Alsophis in many technical characters, except in having a single anal shield, but the latter differs especially in its excessively elongate tail. A close approach appears to be made by Zamenis, but here the anal plate is double also. Bothrophthalmus Schleg. a Lycodont, presents the peculiar loreal groove.

Character specificus. The body is rather compressed, the urosteges not angulate. The scales are in nineteen longitudinal series, and are rather wide on the dorsal region The length of the tail enters the total 5.66 times. The head is broad and flat, and the neck narrow. The rostral plate is flat, and slightly visible from above. The internasals are little shorter than the prefrontals, but not so wide. Both nasals are visible from above, but not the loreal; the preocular reaches the frontal. The latter is as long as the occipitals and rather narrow, with concave borders. Each occipital is as broad as the middle suture; the superciliaries large. The eyes are large and with round pupil.

Nasals about equal; the loreal with a curved supero-posterior margin, which invades the single preocular; postoculars three, the superior in contact with occipital only, the inferior the largest, joining only the fifth and sixth superior labials. The temporals are very small and number 2-3-4. Superior labials eight, fourth and fifth entering orbit; sixth

quite elongate, last two each longer than high. Inferior labials nine; geneials equal, not elongate. Gastrosteges 189, urosteges 70. Total length of a young animal 0m 30; of tail 0m 03.5.

Color above light brown, with a dorsal series of transverse quadrate deep brown spots extending from nape to middle of tail; they extend over seven and two half rows of scales, and are restricted by a light yellow line, which extends on each side the back. The spots are yellow-edged anteriorly and posteriorly. The sides are marked with two rows of alternating pale brown blotches, of which the superior is opposite the dorsal series. There is a triangular dark edged yellow spot on the extremity of each gastrostege; belly closely brown punctate. A blackish band extends from the rostral plate to the side of the neck, and three similar bands with pale middles extend on the top of the head to the nape. Lips and chin yellow, brown blotched.

This species was found by Geo. Sceva, of the Thayer Expedition to Brazil, and is No. 909, Mus. Comparative Zoology, Cambridge, Mass.

LYGOPHIS LACHRYMANS, *Cope.*

This species repeats the generic characters of Lygophis in the diacranterian dentition, lack of scale pores, tail of medium length and normal scutellation.

Scales in seventeen series, obtuse. Muzzle short, rostral shield not as high as wide, not prominent. Internasals broader than long; frontal broad, shorter than occipitals, with a right angle behind. Superior labials eight, fourth and fifth only in orbit, sixth only higher than long. Loreal longer than high; oculars 1–2, the anterior not reaching frontal; temporals 1–2. Inferior labials large, nine; pregeneials shorter than postgeneials. Gastrosteges 173; anals 1–1; urosteges 78.

Color above, chestnut brown; ends of gastrosteges and first three and a half rows of scales blackish, yellowish margined above from side of neck to end of tail. On the anterior half the body is divided by a yellowish band on the first and second rows of scales. Below and labials bright yellow, the anterior superior labials brown margined. A deep brown band from eye across sixth labial, another across seventh, and a black spot on side of neck. Head above brown. *Habitat*, unknown.

This species is remotely like Coniophanes fissidens. It differs from Rhadinaea taeniolata Jan. (*Enicognathus*) in the broader frontal, and the lip bands as well as uniform back.

ALSOPHIS RIJGERSMAEI, *Cope.*

Six specimens of this species serve to represent its characters. In three the scales are in 23 series, in one in 21. The loreal plate is longer than high, and with a straight superior suture, except on one side of one individual, where it is angulated above as in A. antillensis. The muzzle projects considerably beyond the mouth, but the rostral plate is not prolonged on its upper surface. Superior labials eight, third, fourth, and fifth in orbit; these with the sixth are the only labials higher than long. Temporals 1–2 the anterior in contact with inferior of the two postoculars only. One preocular occasionally divided and not reaching frontal.

Nasals different in size, the anterior much smaller and not more elevated than the loreal. Muzzle very narrow, internasals longer than broad, vertical elongate and contracted by the concave superciliary sutures, its anterior suture one-half its length, which equals the common occipital suture. Occipitals emarginate behind. Gastrosteges 201, 201, 204, 210; anal $\frac{1}{1}$; urosteges 100, 122, 108, 100. Length 37.25 inches, of which the tail measures 3.25 inches.

Color, dark slate brown above, with a number of blackish cross-bands behind the head, which are sometimes quite indistinct and sometimes separated by paler bands. A broad brown band from the nostril through the eye which expands and is lost on the temporal region, though its lower boundary is continued as a line on the side of the neck. The scales on the median dorsal line have a white border. Belly, the posterior half black, anterior yellowish, gray spotted. Upper labial region orange, brown spotted; gular region grayish brown and orange mingled. Frontal and occipital plates dark medially. This species is in general appearance much like the A. sanctaecrucis, but it has the loreal plate of the A. angulifer, and several more series of scales than either. The frontal shield is of a narrower form than in either A. sanctaecrucis or A. antillensis.

Habitat. So far as yet known, this distinct species is confined to the small island of St. Martins, in the Spanish West Indies, which has an area of only about thirty square miles. Six specimens were sent to the Academy Natural Sciences by Dr. R. E. Van Rijgersma of that island. I dedicate the species to him in recognition of his labors in endeavoring to lay a basis for the complete zoology of that island.

XENODON ISOLEPIS, *Cope*.

Eight superior labials, fourth and fifth entering orbit, sixth the largest, exceeding the seventh. Anal shield bifid. Scales of the body in nineteen series quincuncially arranged of equal size and form, one pitted. General arrangement that of a Coluber; the body is also as in that type entirely cylindric. Oculars 1–2; loreal little higher than long; postnasal highest; rostral not prominent. Temporals 1–2. Frontal longer than wide, longer than occipital.

Gastrosteges 156; urosteges 55.

Color uniform leaden above, flanks greenish, below dirty white. Posterior tooth rather short. This species is nearest in technical characters to the X. neovidii Gth. but differs entirely in color, and the equal size and form and quincuncial arrangement of the scales. The sixth upper labial is according to Gunther's figure (Ann. Mag. Nat. Hist., 1863, V. C.,) much smaller than the seventh; here the latter is distinctly smaller than the former.

From Pebas Equador on the upper Amazon. Received from Professor James Orton, of Vassar College, New York. A collection recently received from that gentleman from the same locality embraced the following species, all of which are in the Museum of the Academy Natural Sciences, presented through the liberality of Prof. Orton.

Testudinata.

Chelys matamata.

Ophidia.

Typhlops reticulatus, L.
Tortrix scytale, L.
Rhabdosoma microrhynchum, Cope.
Leptodira annulata, L.
Oxyrhopus clelia, L.
Xenodon isolepis, Cope.
Herpetodryas carinatus, L.
Himantodes.
Leptognathus catesbyi, D. B.
Elaps lemniscatus, Linn.
Elaps imperator, Cope, (*E. batesii*, Gthr.)
Elaps scutiventris, Cope.
Bothrops bilineatus (27 series of scales only.)

Lacertilia.

Amphisbaena alba, L.
Amphisbaena fuliginosa, Schreb.
Amiva surinamensis, Gray.
Thecadactylus rapicauda, Houtt.
Anolis viridiaeneus, Peters.

Batrachia.

Pithecopus tarsius, Cope. Specimens with head and body five inches in length.

Pithecopus tomopternus, Cope.
Hyla marmorata, Daud.

Hyla leucophyllata, Beireis. A curious variety with a round or discord blackish spot on the vertex, brown lateral band from end of muzzle, and whole under surfaces a bright salmon color. Another variety apparently has been named *Hyla triangulum by* Günther, P. Z. S. Lond., 1868.

Scytopis allenii, Cope.
Bufo naricus, Spix.
Bufo margaritiferus, Merr.
Pipa surinamensis, L.

ELAPS SCUTIVENTRIS, *Cope.*

Form slender, tail short, thick. Oculars 1-2; superior posterior with its inferior suture continuous with that of the occipital. Superior labials seven, third and fourth in orbit, all except the first higher than long, none reaching occipital. Temporals 1-1. Superciliaries broad as long; prefontals and internasals of equal length, the former much the wider. Rostral broader than high, not prominent. Symphyseal largely in contact with pregeneials. Scales in fifteen series. Gastroteges 274; anal divided; urosteges 15.

Above black, except a broad yellow head-band, which extends from the posterior margin of the prefontals to that of the occipitals. Tail with

one or two crossings above. Below black, with large transversely oval yellow spots, which extend to the third row of scales, and include three or four gastrosteges at intervals of the same width. Length, 17.5 inches, tail, 7 inches.

From Pebas on the Amazon in Equador. From Prof. Orton.

This species appears to be nearest the E. narducci of Jan.

TRIGONOCEPHALUS (Bothrops) ARBOREUS, *Cope.*

Scales in thirty-five longitudinal series, all carinate except the inferior. Eight superior labials which diminish in size posteriorly, bounded above behind posterior line of orbit by seven small scales, which are not distinguishable from those of the temple. Second labial forming anterior boundary of fossa; two rows scales between fourth and orbit. Inferior labials eleven. Three scales on the canthus above, the anterior two large, forming with a pair on top of the muzzle a shielded space of six plates. Supercilaries large, separated by nine rows. Gastrosteges 201, urosteges 64 pairs. The body is much compressed, and the coiled tail with slightly expanded prehensile extremity, appropriately to arboreal life.

Color, greenish yellow, the first series of scales yellow, ends of the gastrosteges with a green line. Dorsal region with faint brownish yellow spots often paired; many scales black edged. Labial scales of both jaws black edged; a black band with yellow interruptions from eye to angle of mouth.

This handsome and venomous tree serpent was discovered by Dr. Otho Wucherer, near to Bahia, Brazil. It is a near ally of the B. bilineatus of Nieuwied, but that animal has 27-9 rows of scales, and the top of the muzzle is scaled, (as given by Schlegel in the atlas of his Physionomie des Serpens), and the color is slightly different.

TRIGONOCEPHALUS (Bothrops) PUBESCENS, *Cope.*

Scales in twenty-three rows, all including the inferior, keeled. Eight superior labials, the fourth longest, and separated from the orbit by three rows of scales. Second not extending to the front of the maxillary pit. Posterior labials quadrate shorter. Seven rows of scales between superciliaries; two on canthus rostralis above, besides the edge of the preocular. The anterior quite large, flat, the second separated by five rows scales. Maxillary, palatine and pterygoid, mandibular and laryngeal margins with the fang sheaths, silky pubescent, forming short longitudinal fringes. Color, brown, with blackish brown spots on each side from vertebral line to fourth row of scales. The spots are rounded and pale edged and alternating. They are divided by a longitudinal line of the ground near their middle. There are in their intervals above, round pale edged brown spots. A brown band from eye to angle of mouth, pale edged below; a similar band across head *in front of supercilliaries;* two divergent brown spots behind the same plates, and two divergent brown bands behind these, all yellow edged. Sides of face and throat thickly brown dusted. Belly closely brown spotted; widest spots near end of gastrosteges. Gastrosteges 182, urosteges 25.

One specimen of this serpent was brought by the Thayer expedition

from the Rio Grande do Sul, Brazil. It is nearest the B. nieuwiedii, Spix, but may be distinguished by the extraordinary character of the silky fringes in the mouth as well as by the entirely different coloration. In the latter respect it is rather more like B. diporus.

CNEMIDOPHORUS GRANDENSIS, *Cope, sp. nov.*

Char. Ten series of abdominal plates; brachium plated; two frontoparietals. Green with 2–3 white longitudinal lines on each side, a row of brown spots between the two superior and above the more dorsal of the latter.

Description. The nostril is anterior to the naso-frenal suture. Infralabials four, separated from labials behind by one series flat scales (not granules), mesoptychium entire, with 3–4 rows plates, some small ones on the margin, except at middle. Supranasals in contact; also the prefrontals. Frontal single, much angulate in front. Supraorbitals four, not separated from frontals and frontoparetals by granules. Two pairs wedge shaped parietals, interparietal parallelogrammic as large as one pair. Scutellation minute, caudal scales strongly keeled. Brachials and antibrachials continuous, latter in two rows only; former continuous with postbrachials, the two forming together five rows, all smooth. Nine femoral pores. Anals continuous with abdominals, composed of one large median plate, margined laterally and behind by six plates, the two posterior marginals.

Coloration.—The inferior lateral pale line is interrupted aud not well marked; sides pale green, between and above the superior lateral lines, brown; median dorsal line bright green. Nineteen brown spots between nape and rump above upper line, those below rather fewer. Femur with two pale streaks behind, tibia and fore-arm spotted in front. Belly and throat uniform yellow.

Habitat. The Rio Grande, Brazil, brought by Capt. George Harrington, and presented to the Essex Institute, Salem, Mass., (No. 388,) Museum Academy Natural Sciences, Philadelphia.

This species only resembles the C. murinus, D. B., and the C. heterolepis, Tschudi in the increased number of its abdominal shields. In C. murinus the brachium is altogether granular, while the C. heterolepis differs in having but one frontoparietal plate, and only two parietals, with frontoparietal smaller than either. It is from Peru.

On account of the united frontoparietal shields I refer C. hyperythrus, Cope as type, and C. heterolepis, Tschudi, as second species of a genus different from the present, under the name of VERTICARIA.

Measurements of C. grandensis.*

Total length.....	0m 19.2	Fore limb.....	0m 02
" to vent.....	0m 06.5	Hind "	0m 036
" to collar.....	0m 01.9	" foot.....	0m 2

AMEIVA ANALIFERA, *Cope, sp. nov.*

Of the group of A. plei, *i. e.*, with twelve ventral series of scales, no

* In the legal measure of the United States the metre and decimal fractions.

heel spurs, and one frontal plate. The tibial shields in three rows, the outer much larger, and outer toe longer than inner. It differs from that species in having the prebrachial shield small, and in three sub-equal longitudinal rows, graduating into the large prebachials regularly, in having ten or eight regular marginal anal plates, the median pairs not abruptly larger, and in not having a series of black spots on the sides. The teeth are from the nostril posteriorly 9 canine like, and seven or eight obtuse molars, two or three posterior usually with a lateral cusp. Two median plates in front of the anals. Gular scales in a transverse band of about nine rows, larger; relatively larger also than in A. plei, also the latter has several rows of scales between the labials and infralabials; the A. analifera but one row.

Greenish yellow below, brownish olive above, with blackish cross-shades on the nape in St. Martin's specimens. Sides, groin and tail above white spotted; some white spots in rows across the rump.

	In.	Lin.
Total length (two inches of tail reproduced).....	13	
End muzzle to vent.....	4	6
Hind limb.....	3	1.5
Foot.....	1	6
Fore limb.....	1	8
Head including membr. tympani.....	1	1.5

Several specimens in Museum Academy from the island of St. Martins, West Indies, presented by Dr. R. E. Van Rijgersma, correspondent of the Academy at that place; also one specimen from the adjacent island of St. Bartholomews, from Dr. A. H. Goës of that island. The following species were included in the collection of Dr. Rijgersma.

IGUANA NUDICOLLIS, Cuv. This species occurs also in the Swan Islands off the coast of Honduras; Museum Columbia College, New York.

ANOLIS GINGIVINUS, Cope, P. A. N. S., Philadelphia, 1864, 170.

AMIVA ANALIFERA, Cope, supra.

MABUIA AENEA, Lacep.

ALSOPHIS RIJGERSMAEI, Cope, supra.

HYLODES MARTINICENSIS, Dum. Bibr.

SCELOPORUS SINIFERUS, *Cope.*

Twenty-four transverse series of scales between interscapular region and rump. Seven longitudinal series at the latter point, ten at the former. Lateral scales large, nearly equalling the ventral, which are considerably smaller than the dorsal. All well keeled and mucronate, except the ventral, which are smooth and without mucro or emargination, except a few spinous series in front of the vent. Gular scales entire. Palms and soles strongly keeled; tail slender, its scales strongly keeled like those of the back. Male with three, female with six femoral pores. No granular space in front of shoulder, and no longitudinal folds in the same region, but a short vertical fold in which the skin is so deeply inverted as to

form a deep pocket extending more than half way to the tympanum, and with some subdividing folds. No auricular scales different from the temporal; all strongly keeled.

Two pairs of supranasals, two pairs frontonasals separated by a small internasal. Frontal divided transversely and longitudinally; frontoparietals small. Parietals small, transversely divided; interparietal large, broader than long. Supraorbitals four on each side, preceded by three scales, and bounded inwardly and outwardly by much smaller scales. None striate; those on muzzle weakly one keeled.

	In.	Lin.
Total length	6	8.2
Length to vent	2	1.4
" to axilla		10.2
" to canthus oris		5.3
" hind limb	1	8.4
" " foot		10.1
" fore limb		10.6
Width head		4.8

This species is comparable to S. oligoporus, Cope, in the large scales and few femoral pores, but differs much in the division of the frontal plate, large interparietal and cervical pocket. It is considerably smaller and of different coloration.

Numerous specimens in Smithsonian collections from Francis Sumichrast, from the Pacific side of the Isthmus Tehuantepec.

LIYLA RUGULOSA, *Cope, sp. nov.* Cystignathidarum.

Prefrontal bones in close union with each other and the fronto-parietals. Vomerine teeth present; auditory apparatus well developed. Manubrium cartilaginous, xiphisternum emarginate. Toes webbed; dilatations well developed, supported by T-shaped phalanges. Abdomen nearly smooth.

This genus is very near to Hylodes,* differing almost entirely in the webbed toes. Keferstein, who has just described this genus (Archiv. f. Naturgesch, 1868, 926), in consequence of his adhesion to the system of Günther, has attained to a very confused idea of its affinities.

Character Specificus.—Head broad, body short; heel extends to end of muzzle. Vomerine teeth in two approximated fasciculi, much behind the posterior line of the nares. Choanae half the size of the ostia pharyngea. Tongue oval, one-fourth free, openly emarginate behind. Tympanum nearly as large as orbit. Skin thin, with sundry rugosites on the sides of the dorsal region. Muzzle acuminate, not projecting; nostrils nearly terminal. Canthus rostralis well marked, lores slightly concave; front a little convex. Tarsal fold slight, metatarsal tubercle one inner. Solar web to the middle of the first (proximal) phalange on the first and fifth digits; to the base of the same on the others. Third

* Lithodytes rhodopis, Cope, Pr. A. N. Sci., Phil., 1866, 323 is *Hylodes sallæi*, Gthr. P. Z. S. Lond., 1868.

digit very elongate. Anterior toes free; lengths 2-4-1-3. A weak discoid abdominal dermal fold. Abdomen very obscurely areolate, medially nearly smooth.

Color blackish-brown above, sometimes with pale vertebral streak. Femora not marked behind; above with three oval brown areas enclosed by light lines. A black band between orbits. A dark band from orbit to nostril, and thence to lip; two similar bands from orbit to lip. Below unspotted white, except gular region, which is brown.

Length head and body	0m.	.037
" " to posterior line tympanum		.014
Width " at canthus oris		.0145
Orbit to end muzzle		.0049
Length fore limb		.0215
" " foot		.0105
" hind foot minus tarsus		.0185
" " limb		.064

Habitat. Two specimens of this new form were sent to the Smithsonian Institution by Dr. Francis Sumichrast from the Pacific region of the isthmus of Tehuantepec, Mexico.

The collection sent from this locality embraced the following thirty-six species.

CROCODILIA.

CROCODILUS AMERICANUS, Seba; various large specimens, which display the most remarkable variations in the number and position of the osseous scuta. They exhibit from two to four nuchal scuta, and from two to five cervical. In several specimens scuta of the external dorsal series meet on the median line, excluding the inner pair entirely.

TESTUDINATA.

CHELOPUS RUBIDUS, Cope Supra.

LACERTILIA.

HELODERMA HORRIDUM, Wiegmann.

CNEMIDOPHORUS, sp.

UTA BICARINATA, *Phymatolepis bicarnatus* Duméril.

SCELOPORUS SINIFERUS, Cope.

SCELOPORUS VARIABILIS, Wiegmann.

CYCLURA (*Ctenosaura*) QUINQUECARINATA, *Enyaliosaurus quin.* Gray. Catalogue of Sauria in Brit. Mus. This region is the undoubted home of this hitherto rare species, as Sumichrast finds it in abundance. Gray was unable to assign its habitat.

CYCLURA (*Ctenosaura*) ACANTHURA, Wiegm.

IGUANA RHINOLOPHA, Saur. Probably only a variety of I. tuberculata.

OLIGOSOMA GEMMINGERI, Cope.

PHYLLODACTYTUS TUBERCULATUS, Wiegmann.

OPHIDIA.

STENOSTOMA.

OGMIUS VARIANS. *Oxyrhina varians* Jan. This genus is strongly glyphodont like Stenorhina. Prof. Jan considered it is isodont. His name *Oxyrhina* has been used variously before, on which account I propose the name above given. For a synopsis of genera allied to Ogmius. See Silliman's Journ. Sci. Arts, 1864, 457.

STENORHINA VENTRALIS, D. B. A form with series of dots on the scales, confirming the identity of the lined var. freminvillei with the species.

OPHIBOLUS POLYZONUS, Cope.

CONIOPHANES PICEIVITTIS, Cope.

CONOPHIS VITATTUS, Peters.

TOMODON NASUTUS, Cope.

OXYRHOPUS CLELIA, Linn.

LEPTODIRA MYSTACINA, Cope.

LEPTODIRA ANNULATA, Linn.

TRIMORPHODON BISCUTATUS, D. B (Dipsas).

TRIMORPHODON TAU, Cope, supra.

SYMPHIMUS LEUCOSTOMUS, Cope, supra.

MASTICOPHIS MARGARITIFERUS, Schl.

OXYBELIS ACUMINATUS, Wied.

ELAPS AGLAEOPE, Cope.

ANCISTRODON BILINEATUS, Gthr.

BOTHRIECHIS BRACHYSTOMA, Cope.

BATRACHIA.

LIYLA RUGULOSA, Cope.

CYSTIGNATHUS MELANONOTUS, Hallow.

CYSTIGNATHUS GRACILIS, *D. B.* Not distinguishable from specimens in the Mus. Compar. Zoology from Uruguay, except in less depressed extremity of the muzzle. The same species from Vera Cruz.

SCYTOPIS ALLENII, *Cope.*

Fingers free and teeth in fasciculi between nares and otherwise generally as in P. xsignatus; but the muzzle is broadly rounded, there is a black band from eye to middle of sides, followed by numerous large black spots on yellow ground; femora not cross-barred above, with large light spots on black ground.

The black scapular bars of this species are broad, and are not angulated and converging as in S. xsignatus, but are parallel; two black bars on sacral region diverge towards the groin. There are several black spots in the axilla, and longitudinal black line on front and back of humerus and three on front and under side of humerus. Tibiae vermiculated on

under surface above with an incomplete outlining of cross bars. Teeth between nares. Proportions of limbs generally as in the common variety of S. xsignatus; head equal foot beyond tarsus less the last phalange and two-thirds the tibia; foot 1.5 head and body. Orbit equal muzzle to beyond nares; belly immaculate, throat smooth. Heel nearly to nares. Length head and body 15.25 lines.

Habitat. Para Brazil. One specimen, No. 473 Mus. Comp. Zoology, Cambridge, Mass. Pebas Equador, Prof. Orton. Named for my friend, Prof. Harrison Allen, of the Pennsylvania University.

HYLA PULCHRILINEATA, *Cope.*

Form that of H. arborea. Fingers free, toes webbed to the base of the penultimate phalange. Dilatations well developed. Vomerine teeth in a single transverse series opposite the posterior margin of the internal nares; the latter much larger than the ostia pharyngea. Tongue slightly free behind. Canthus rostralis distinct, lores concave. Eyes large, prominent; membranum tympani one-fourth their size. The skin is smooth above, and the areolae of the abdomen are unusually weakly developed. No dermal appendages to the limbs or body. The extended hind limb brings the heel to the front of the orbit.

	mm.
Length total axial	38.
" to eye not axial	58.
" to posterior margin tympanum	11.7
" fore limb	22.8
" hind limb	58.5
" foot	24.5
" tarsus	12.
Width at canthus oris	12.4

Ground color above pale ashy brown. A strong citron yellow band passes round the muzzle, below the tympanum, and along the side to the groin. On the side it is wider, slightly undulating, and bordered above and below with slate color, which forms a pale blotch below it on the groin. A narrow unmargined, bright citron yellow line extends from the end of the muzzle to the vent, medially; and a similar one passes above the canthus rostralis and orbits along a line equidistant between the vertebral and lateral lines, joining the latter at the groin. The femora are finely yellow above and behind, and a yellow longitudinal line marks the tibia on both the inner and outer sides. The pigment of the metatarsus does not extend on the outer digit.

This pretty and uniquely marked species was brought by William M. Gabb, member of the Academy and Chief of the Geological Survey of the Island of San Domingo, from the eastern part of that island. The thumb can be opposed to the fingers as in the species formerly referred to *Litoria.** The sacral diapophyses are narrower than usual in the genus. The fronto-

*Two species were described by Dumeril as L. marmorata and L. punctata, from Australia. On the union of these with Hyla, I changed their names to H. thyposticta and H. dimolops respectively (Journ. A. N. Sci., 1866, p. 85), as there were Hylae already described under those names.

parietal bones are more extensively ossified than in most species of Hyla, and constitute an approach to Scytopis,* Cope. The species is the first true Hyla discovered in the West Indian subregion.

The species brought by this naturalist from the same locality are :—

Dromicus parvifrons, Cope.
Uromacer catesbyii, D. B.
Amphisbaena innocens, Weinl.
Anolis semilineatus, Cope.
Anolis cœlestinus, Cope.
Anolis distichus, Cope. *A. dominicensis* Lütk. is a variety of this species.)
Anolis cybotes, Cope. *A. rüsei* Reinht. and Lütk.
Trachycephalus marmoratus, D. B. var.
Hyla pulchrilineata, Cope.
Lithodytes ricordii, Dum. Bibr.

It may be mentioned in this connection that a valuable catalogue of West Indian Reptiles and Batrachia was issued by Reinhardt and Lütken in 1863 in the Naturalist. Foren. Vidensk. Meddel. Kjobenhavn. A few *doubles emplois* occur in its pages, as follows. Their *Anolis trinitatis* I think is a variety of A. alligator, D. B. Numerous specimens are in Mus. Smithsonian. *Amphisbaena antillensis*, Rhdt. and Lütk. is Diphalus fenestratus, Cope. *Liophis Andreae*, R. & L., is the young of Dromicus fugitivus, Donnd. *Hylodes riseii*, R. & L., is Lithodytes lentus, Cope, and H. *antillensis* is H. auriculatus, Cope. Though this paper of the Danish naturalists was read one month before that of the writer, in which these Hylodes were described, it was evidently published much later, as they quote in it a paper of the writer's, which was not issued till 1863.

Among West Indian Anoles it is to be added, that the A. grahami Gray is established on a young A. iodurus, and that A. porcatus is A. principalis; also that A. stenodactylus is not a valid species.

HYLA POLYTAENIA, Cope.

Hyla rubicundula, "Reinhdt. & Lütk." Günther P. Z. Soc. Lond., 1868, 489, Tab. X, fig. 3, nec. Reinh. et Lütk.

Fingers one-third palmate; toes only palmate to the extremity of the basal phalange of the longest toe. No dermal margins on body or limbs. Tongue entirely attached behind. Vomerine teeth in short transverse fasciculi entirely behind the line of the posterior margin of the inner nares. Choanae smaller than nares. Tympanum less than one-fourth eye. Skin above everywhere smooth. Digital dilations moderate; eye large; head wide; muzzle short; loveal region concave.

* Four species of this genus are enumerated in my genera of Arcifera (Journ. Acad. 1866) but were not named. They are S. venulosus (Hyla Daudin); S. acuminata (Hyla Cope); S. allenii Cope and S. ruber (Hyla Daudin).

	Inches.
Length from end muzzle to orbit	.20
" " " behind tympanum	.40
" " " veub (oxial)	1.30
" of fore limb	.90
" of hind limb	2.00
" of foot	.90
" of harsus	.56
Diameter eye	.39
Width head behind	.41

The pigment of the upper surfaces extends to near the edge of the lip and in a band on humerus and femur, covering three outer fingers, an outer metatarsus and two outer toes. A grey-brown band extends along the border of the lip above the axilla to the groin; a second and wider extends from the nares through eye and tympanum to groin. In our specimen the reddish-cream color of the dorsal region is marked with indistinct dap; in a second, with nine longitudinal grey-brown lines, of which a vertebral, and one from above the lores and over each orbit to groin are band-like. In both, a similar band bounds the antebrachium, tibia and metatarsus, and the posterior margin of the pigment on the femur. In the lined specimen there are additional lines on the lips humerus and femur.

This species has the opposable thumb and slight palmation of some of the Hylae referred to Litoria. It is in general allied to H. palliata, but has the toes much less palmate, and the vomerine teeth more posterior.

This species is figured by Günther as the H. rubicundula of Rhdt. & Lütk. as above. It is however not that species, which differs according to the original description in Danish, in first, having the vomerine teeth between the nares: second, in having the tongue half free; third, the palmation of the feet extends over one phalange more, and fourth, that of the fingers is better developed.

From Brazil; collected by G. Sceva, of the Thayer expedition to that country, under Prof. Agassiz. No. 906 Mus. Comparative Zoology, Cambridge.

STEREOCYCLOPS INCRASSATUS, *Cope, sp. et. gen. nov. Phryniscidarum.*

Char. gen. Of section I. of Phryniscidae with Hypopachus and Calophrynus. The prefrontals are fully developed and form a continuum with each other and with the fronto parietals. Tongue large. Membranum tympani thin, concealed. No dorsal or parotoid gland; no metatarsal shovel. Coccyx united by two condyles. Xiphisternum cartilaginous, much dilated and entirely in contact with the coracoids. Anterior portion of the sclerotica ossified, so as to form a hard annulus round the cornea. Pupil round. Toes free.

Char. Spec. The whole form is much depressed, and the physiognomy approaches Pipa. The cranial box partakes of this and presents a strong median longitudinal crest. Tongue large; equal inner nares. A short

frenum across the palate behind. The vomer is cartilaginous between the nares, except on axis. Gape large, the muzzle projecting slightly beyond it. No canthus rostralis, nostrils latero-superior. Limbs short, humerus and femur included in the skin. Toes very unequal, the inner and outer very short; related thus, 1-2-5-3-4. An obtuse tubercle at the base of the outer toe. The epidermis is everywhere thickened by a chitin-like deposit, which is readily cracked. It is thickest on the soles, the tarsi, and the gular region.

Color everywhere leather-brown; a narrow white line from end of muzzle to vent.

	MM.
Length of head and body	.057
" " hind limb from knee	.0495
" " tarsus	.009
" " remainder of foot	.0245
" " fore limb from elbow	.0200
Width between angles mandible	.020
" " orbits	.009
" " nostrils	.004

Found near Sao Matheos, south of Rio de Janeiro, by Messrs. Hartt and Copeland, of the Thayer Expedition to Brazil, Mus. Comparative Zoology, Cambridge, Mass., No. 855.

This is a remarkable type, with a certain resemblance to Engystoma. It is the first type among the Raniformia which betrays even a remote resemblance to Pipa.

HYPOPACHUS INGUINALIS, *Cope, sp. nov.*

This species is of about the same size as the H. variolosus Cope, and like it has the toes partially webbed at the base. It differs by many marked characters throughout.

Muzzle rounded conic, projecting beyond lip; nostrils superolateral. Width of head behind orbits, double length to opposite the same point. A groove from orbit to humerus. Diameter of former equal length of muzzle from the same. Mandible with symphyseal knob little marked; gular slits large; tongue flat, ovate, largely free and thin behind, without free border in front. Nares large, double the small ostia pharyngea. Two metacarpal tubercles close together; fingers slender, with subarticular knobs. The metatarsal tubercles with cutting edges in nearly the same line without blackening of the sheath, the inner the longer. No tarsal fold. Skin everywhere smooth, except some minute pappillae on the sacro-coccygeal region.

Coloration. Above a pinkish leaden, with a more or less indistinct narrow vertebral line from the end of the muzzle. A large and a small black spot on the groin and one on the knee. A large black spot on the scapula; a pair of blackish lines which converge from the orbits to the inter-scapular region, then diverge and form an imperfect circle on the middle of the back. Sides of head blackish; a yellow bar from orbit to humerus. A black bar across closed femur and tibia above. The femur

is a strong pink, and is sometimes spotted behind and sometimes not. Belly with delicate reticulate brown lines on yellow ground, sometimes obsolete. Total length, 04″ 4‴; do. to orbit behind, 8‴. Fore limb, 02″ 2‴; hand, 01″. Hind limb, 04″ 1‴; harsus, 9‴. Entire foot, 02″ 03‴.5.

Habitat. Vera Paz, near the ruins of Coban. Sent to the Smithsonian Institution by Henry Hague. This gentleman has made highly interesting observations on and contributions to the Natural History of that once populous, but now almost unknown region, which have been communicated to the Smithsonian Institution.

The known species of this genus is Hypopachus variolosus Cope (*H. seebachii* Keferstein Göttingen, Nachrichten, 1867, 352. Archiv. f. Naturgesch, 1868, 293, tab. IX., f. 1, 2. *Engystoma variolosum* Cope. Proceed. Acad. Nat. Sci., Phila., 1866. *Systoma* do. Journ. A. N. Sci., 1867, 194,) which is found in Costa Rica. Keferstein well separates this species from Systoma on account of its claviculus, though it is not certain that it is not Copea Steindachner. In an essay on Costa Rican Batrachia this author enumerates eight species. Of these it may be remarked that *Bufo sternosignatus* Günther has been described by an older author under a prior name. *Oedipina uniformis* Kef. is an interesting Plethodont salamander, apparently the same as the *Opheobatrachus vermicularis* of Gray. No generic characters are given which are not possessed by species of Oedipus. I may mention here that I have hitherto regarded the latter genus as identical with Geotrition, and no author has presented characters by which to distinguish them. I find, however, that the European genus possesses two premaxillaries, the American one; on this ground they may be separated. In the same way Spelerpes porphyriticus (vel *salmoneus*) has two premaxillaries, and all the Spelerpes proper but one. I therefore refer the first to a new genus under the name of Gyrinophilus.

Ranula affinis, *Peters, Cope.*

This species is extensively distributed. We have it from Pebas, Equador, Coban Guatemala, and the Rio Verde, Tehuantepec, Mexico. Günther, after examination of this frog, says (Zoological Record, 1868,) that it is "Hyloid," an expression we fail to comprehend, as he certainly cannot mean that it bears any relationship to Hyla.

The digital relations, if such they can be called, are not larger than in the Rana sylvatica, which has just passed its metamorphoses. It is in fact most closely allied to the group of Rana to which R. temporaria belongs, as already perceived by Peters, who calls it *affinis* on this account. Like it, it possesses a dorso-lateral dermal fold, as is common in Hylorana.

Steindachner proposes to united Hylorana and Polypedates. On this Günther remarks that this herpetologist could not have devoted much study to them, as they differ in the presence and absence of this dorso-lateral dermal fold respectively. Günther's criticism, however, like most of those which he too frequently directs at the labors of his fellow-students, is really applicable to himself.

So far as the "Catalogue of Batrachia Salientia in the British Museum" is concerned, no characters to distinguish them can be found. But I pointed out, some years ago, that the difference consisted mainly in the structures of the distal phalanges characteristic of each : also that Hylorana is much nearer to Rana, and is only to be distinguished from it generically, without the interposition of any possible form which would not unite them. The T-shaped phalange in some Hyloranae is so weak, while the expansion of the tip of the same in Rana temporaria and others, is so distinct, as to render the permanent distinction of the two genera a mere matter of future discovery.

LIMNOMEDUSA MACROGLOSSA, *D. B.*

Having had an opportunity of examining the sternum of this species for the first time, I find that it possesses the styloid xiphisternum which I have indicated as characteristic of the typical group Cystignathi of the family Cystignathidæ, and it must therefore be referred to the neighborhood of Cystignathus. Besides other points, Limnomedusa, Cope, is distinguished from Cystignathus by the vertical pupil.

Keferstein states that I erroneously ascribe an osseous stylus of the xiphisternum to the genus Borborocaetes Bell. The facts are as follows : This genus was distributed by Günther in the Catal. Bat. Sal. Brit. Mus. in two widely different groups, Cystignathus, and one he called *Limnodynastes.* I first pointed out* that this series of species differed radically from Cystignathus and its allies, in the *scutiform cartilaginous* xiphisternum, and also in the large cranial frontanelle.

Up to that time the Australian species called *Limnodynastes* had never been received other than specific characters, as that by which it was stated by Günther to differ from Cystignathus, viz., the transverse extension of the series of vomerine teeth, is one included in the range of many well-known genera, as Rana, Lithodytes, and Cystignathus itself. The South American species named by Bell long previously, Borborocaetes, differ only from those of Australia in the shortening of these series, and not more than Cystignathus taeniatus does from C. albilabris.

GOMPHOBATES BILIGONIGERUS, Cope.

Gomphobates notatus, Reinhdt. and Lütken, Vid. Medd. Copenhagen, 1861, 33 Tab. IV, f. 3. *Liuperus biligonigerus*, Cope, Proc. Ac. N. Sci., Phila., 1860, 517. Uraguay.

EUSOPHUS NEBULOSUS *Cope, Cystignathus nebulosus Girard.* It is probable that the Cystignathid described by Günther, P. Z. S., Lond., 1868, 482, as *Cacotus maculatus*, is a variety of this species. It agrees in all respects except in having a black suborbital spot, and line on the canthus rostralis, which Girard's types do not exhibit. Günther places it among his Bombinatorina. It is scarcely necessary to observe that it has not the least affinity to Bombinator.

* Nat. Hist., Review 1865.

APPENDIX.

ZONURUS TROPIDOSTERNUM, *Cope, sp. nov.*

Char. Scales $\frac{1}{1}\frac{2}{4}$=16, lateral ventral, pectoral and gular keeled, the dorsal keeled and very rugose. Caudal scales trihedral spine-like. Internasal reaching rostral. Dark-brown, yellow below.

Descr. This species belongs to the typical group and is near the Z. griseus of the Cape, but differs in many characters. The rostral is in contact with the internasal, which is much longer than wide, and of course separates entirely the supranasals. It is well separated from the frontal by the frontonasals. The other head plates are similar, except that there are six rows of temporals, the longest seven deep; those of the Z. griseus are much larger, including the two marginal auriculars, which are rudimental in the new species. All the plates of the head are excessively rugose, with longitudinal striae. Upper labials six, the fifth not more elevated than the others; inferiors, six; infra-labials, five; all in contact, and without larger scales within them. Gular scales in 22 series from angles of mandible; those of the neck abruptly larger, mucronate, forming a rudimental collar. Median ventrals nearly smooth, laterals mucronate keeled. No lateral fold; lateral scales increasing regularly in size from the ventrals, sub-round, widely separated from each other by minutely granular intervals, strongly muconate keeled. Dorsal scales in 24 series from nape to opposite femur, all strongly mucronate keeled, and rugose; the median series like the others. Caudal whorls very spinous, the scales not serrate, but striate on the surface. Femoral pores, seven on each side; preanal plates small, equal, except two marginal a little longer.

Muzzle to vent	0 m 09″ 2‴	Width head...	0 m .02″
" " ear.....	04″ 4‴	Hind limb.....	" 04″ .2″
Fore limb.....	3″ 2‴	" foot.....	" 02″

Color. Below and upper lip to ear, yellow; above rich brown, with several indistinct blackish cross-shades, head above, wood brown.

Habitat. Madagascar, Mus. Essex Institute, No. 500.

EXPLANATION OF PLATES.

PLATE IX.

Claudius angustatus, Cope. Yucatan, Mus. Smithsonian, Proc. A. N. Sci., Phila., 1865. This plate with the others presented to the author by Joseph Jeanes.

PLATE X.

Cachryx defensor, Cope, Proc. A. N. S., Phila., 1866, 124. Yucatan, Mus. Smithsonian.

PLATE XI.

Laemanctus alticoronatus, Cope l. c. 124. Mus. Smithsonian, Yucatan.

To Brevet Major-General A. A. Humphreys,
Chief of Engineers U. S. Army.

Sir—At a recent meeting of the American Philosophical Society it was stated by one of the members that there remained on file in the Engineer Bureau, U. S. A., several reports of explorations in the Territories of the United States, awaiting the necessary funds for publication.

The Secretaries of the Society were thereupon directed to address you on the importance of rendering the scientific parts of the reports, and more especially those relating to the geology of the regions traversed, accessible to the public, with as little delay as possible.

The American Philosophical Society, ever mindful of the object of its organization, "for promoting useful knowledge," feels particular solicitude in everything that concerns the great mineral resources of the interior of the continent, called by President Grant the strong box of the nation, and knowing that the geological explorations referred to have been made by men eminent in science, and deserving of the confidence of the community, is anxious that the results of their labor, acquired at great cost to the government, shall not be superseded, or the wise cautions contained therein rendered nugatory, by explorations conducted in the interests of private speculations.

The liberal appropriation granted by the last Congress to the geological survey of Nevada and Utah under Clarence King, Esq., has caused the Society to hope that an application for the means to publish the scientific results already obtained, and now on file, may not be without success.

In conclusion, we would add that the present communication, as directed by the Society, is intended for use, at such time and in such manner as you may think most proper for carrying out the object desired, and to aid you, so far as lies in the power of the Society, in rendering assistance, as you have heretofore done, to the great scientific and industrial interests of our country.

Signed, Charles B. Trego, E. Otis Kendall, John L. Leconte, J. P. Lesley, Secretaries American Philosophical Society.

Office of the Chief of Engineers,
Washington, D. C., July 8, 1869.

Gentlemen—Your letter of the 26th ultimo, respecting the publication of Reports of Explorations, affords me great satisfaction, since it informs me of the powerful aid of the American Philosophical Society in securing authority to complete some of the chief objects of the explorations of our Territories by disseminating the information obtained as to their resources and the means for their development.

It gives me pleasure to state that the Secretary of War has sanctioned the publication of the Report on Geology, by Dr. Hayden, in connection with the exploration of the Yellowstone and Missouri rivers, and that it is now in the hands of the printer, and will soon be ready for distribution.

The results of Mr. Clarence King's surveys in Utah and Nevada, will be published as soon as they are prepared, Congress having made provision for it. The Report of Captain, now Brevet Brig. Gen. J. H. Simpson, has not been printed. It is hoped, however, that authority for the publication of the scientific portions at least will be given, and to this end your letter will afford valuable aid.

There are no other reports of explorations on the files of this office.

Cordially thanking the Society for its support, I have the honor to be, very respectfully, your obedient servant,

A. A. Humphreys,
Brig. Gen. and Chief Engineer.

Synopsis of the Extinct Mammalia of the Cave formations in the United States, with observations on some Myriapoda found in and near the same, and on some Extinct Mammals of the caves of Anguilla, W. I., and of other localities.

By Edward D. Cope.

The following list is published in consequence of the discovery by the writer of a number of species of Mammalia in a cave breccia in Virginia. As the number of species previously described as having been found in similar situations is but small, they have been added. I have not inserted the extra-cave species of the beds known as Champlain, since it is not certain that they represent parts of the same fauna, though it is highly probable that they do. The coexistence of a number of species apparently still living on our territory, with some restricted to South America, and with others entirely extinct, is a point of considerable interest. The cotemporaneity of man with the Mastodon on this continent is not a matter of doubt*; and the coexistence of the Mastodon and recent peccary D. torquatus, and the extinct D. compressus is equally certain. These species were cotemporaneous at Galena, with a fauna quite similar to that which I found in Virginia.

The cave breccia consists, in the localities where examined by me, of a number of irregular masses, occupying depressions and short galleries, in the southeast side of a line of hills in Wythe County, Virginia. When these masses are excavated from their beds the floor and roof of a portion of a cave is exposed, with the stalactites, stalagmites, and usual incrustations. Sometimes the termini of the masses could not be reached, and they wound about between large blocks of limestone which once, no doubt, had lain on the floor of a subterranean chamber.

The teeth and bones were discovered at three different points; two of them near together, on the property of Abraham Painter, and the third about three miles on the same side of the same ridge. The Kanawha (New) River cuts the hill at the latter point, and on the side of a bluff the cavity occurred, containing Castor, Dicotyles, etc. On the other side of the same ridge, three miles further in the same direction, I examined several similar cavities of breccia, but could find no organic remains, while Abraham Painter, an old resident and careful observer, informed me that the deposit could be found on the hill side, in continuation of those on his property, for a distance of two miles in the opposite direction.

The limestone of this ridge abounds in the Carbonates of Lead and Zinc, and there can be little doubt that they predispose the rock to easy decomposition. It is also probable that, as Lesley shows, the decomposition has been followed by the successive deposit, as a precipitate of the more insoluble Silicates of those metals. This is rendered highly probable by the mode in which the silicates occur with reference to the carbonates. While the latter are distributed through the limestone rock

* See Leidy, Nott and Gliddon Indigenous Races of the Earth, p. xviii.

in place, the former occupy irregular pockets, caverns and veins. They occur as incrustations, sometimes tubular and of singular tenuity, as well as in masses.

The breccia caverns no doubt had their origin in the same way. The ready decomposition of the limestone has permitted them to be rapidly formed and filled again.

It is interesting to note that the only similar bone deposits occur in the galena bearing Hill Limestone of Illinois. These have been described by Drs. Leconte and Leidy, and their species are included in the present list.

MEGALONYX JEFFERSONII *Harlan*. Fragments of teeth. Found also in caves in Tennessee, Georgia and Alabama.

STEREODECTES TORTUS, *Cope, gen. et. sp. nov.*

This animal is represented by a nearly perfect upper incisor tooth, and fragments of numerous others. It appears to be a rodent, and the tooth in question presents several points of resemblance to that of Arctomys monax, from which it does not differ much in size. The characters which determine its distinction from that genus are very important, and indicate widely different affinities. The central pulp cavity is exceedingly small, and the tooth for a length no doubt considerably above that of the A. monax, solid, with that exception. At the distal fractured extremity it is narrowly linear in the plane of compression of the tooth, while at the proximal fracture it is round, and of perhaps a shade greater diameter. The anterior face of the tooth is as usual, covered with an enamel layer about as thick as that in Arctomys, which extends round the outer face, covering its anterior two-fifths, and is very slightly decurved on the inner plane face. Viewed from the centre of the arc which the tooth describes, the shaft is seen to form a slight sigmoid. The posterior narrowed margin forms a still stronger sigmoid, throwing the extremities of the shaft in opposite directions. I have not observed this torsion in any living genus of Rodentia, except in abnormal specimens.

The specific characters are as follows: A section of the shaft is a nearly isosceles spherical triangle. Distally the inner face is more nearly plane than the outer, while proximally the outer is the less oblique of the two. The anterior face is convex in section, and regularly continuous to the outer side. There is a slight groove below the edge of the enamel on the inner side, and a few weak transverse indications across the shank. The enamel is nearly smooth, under the microscope displaying weak, minute striae, much as in Arctomys. The arc in profile is a perfectly regular segment of a circle. The color is white, and this in a matrix where the yellow color of incisors of other Rodentia is well preserved.

	Lines.
Length of chord between outer circumference at fractured ends	16.
Long diameter proximal end	2.8
Short " " "	1.8

I am unable to throw much light on the affinities of the animal which

bore these teeth. They are more compressed than in the Beaver, and deeper than in the Vischaca; they are not so narrowed anteriorly as in the agutis. The solidity is only approached by the Castorides ohiensis, and to some degree Amblyrhiza inundata, of the same period.

CASTOR FIBER, *Linn.* *C. Canadensis, Kuhl.*

Portion of mandible with three molars, not distinguishable from recent specimens.

NEOTOMA MAGISTER, *Baird.* Mammals of North America, p. , tab.

Said to be larger, and otherwise different from the following. Found in the Bone Caves near Carlisle, in the great Appalachian Valley, in Pennsylvania.

NEOTOMA ? FLORIDANUM, *Say. et. Ord.*

A superior molar, incisors, and other portions. The first is not larger than in recent animals, and does not conform in peculiarities to those ascribed by Baird to his N. magister from the Pennsylvania Bone Caves. The latter is, however, described from mandibular pieces.

The recent Neotoma of this species is exceedingly common in all of the caves which I examined. Their marks can be found from near the mouths to the most remote recesses. They build, in dry places in the more distant chambers, nests of complete and durable construction. In such a chamber in the Hoge's Cave, Montgomery County, Va., I found a number of these nests near together and fastened by interwoven sticks and corn-husks in some mass, to the points and crevices of the rocks. The upper surface of the pile, in which the nest was made, was composed apparently of chewed linden bark, forming a soft, tough, and nearly white material. This surface was always oblique, and enclosed a round cavity, large enough to hold one's two fists, which was entered by a mouth a little more contracted than the whole diameter. Numerous fresh seeds of the Celtis pumila lay about them. They are sweet, and the small tree which produces them is abundant where the traces of the cave were found. Seeds undistinguishable from these are abundant in the limestone breccia with the remains of Neotoma, and testify to the identity of habit of this species in the days of Tapirs, Peccaries and Sloths.

ARCTOMYS MONAX, *Gmel.* The Ground Hog. One nearly perfect ramus mandibuli with all teeth but the last molar, not distinguishable from recent examples.

Found also at Galena. (See Leidy, Trans. Amer. Phil. Soc., XI., p. 100.)

ARVICOLA, *Sp.* Noted by Leidy, l. c., from Galena, Ill.

GEOMYS BURSARIUS. Leidy, l. c., p. 100.

Found at Galena by Dr. E. D. Kittoe with numerous other species enumerated by Leconte and Leidy.

HESPEROMYS ? LEUCOPUS, *Raf.*

Molar teeth undistinguishable from those of this common mouse.

TAMIAS LAEVIDENS, *Cope, sp. nov.*

This ground squirrel is indicated by the distal half of a mandibular ramus, with adjacent fragments, probably of maxillary and squamosal. The successional first molar appears above the alveolar border, and another tooth apparently is in place, but so encrusted with calcite, as to be quite obscured.

This species differs in three marked peculiarities from the T. striatus. The first molar has two anterior cusps instead of one; they are separated by a deep groove; there is also a little cusp between the external two. The incisor teeth are not striate grooved on their anterior face, as in T. striatus, though they have three narrow grooves on the outer longitudinal angle; they are wax yellow anteriorly. Third, the ramus is more slender, especially in the portion anterior to the molars; the depth at the mental foramen is just half the length between the first molar and the base of the incisor above. As in T. striatus, this foramen is nearer the superior outline of the ramus. There is less curvature visible in the inferior face than in some individuals of the existing species.

	Lines.
Length ramus auterior to m. 1	2.6
Depth at mental foramen	1.4
" " first tooth	1.7
Diameter incisor	1.
Depth at m. 4	2.2

SCIURUS PANOLIUS, *Cope, sp. nov.*

A small squirrel of the size of the Chipmunk (Tamias striatus), but of the type of dentition and form of the Sciurus hudsonius. It is represented by a ramus mandibuli, containing two molar teeth, and the included portion of the incisor, the coronoid, and vertical ramus being lost. Numerous fragments, including incisors, etc., are probably to be referred to this species.

The ramus is quite flat, being perfectly plane on the inner face, below the molars; its diameter below the first is equal to that at the incisive alveolar margin above. The series of molars is very little oblique to the plane of the ramus, and, judging by the positions of the anterior three, not curved. There is, therefore, but a slight projection of the alveolar border on the inner face of the ramus. The least depth of the edentulous portion, equals the chord from the base of the first molar to the edge of incisive alveolus. The mental foramen is near the middle of this length, and a little above the middle of its depth. The anterior margin of the masseteric fossa, is below the posterior third of the first molar.

The two molars are well worn, the first being successional: the animal was therefore adult. The worn faces are concave; the inner anterior point of the margin is the most elevated, while the two external lobes are in both the most prominent. There is also a slight emargination on the inner face. The first molar is about as long as wide, the second a little wider than long, and slightly oblique forwards and inwards; the inner

and outer lateral margins in each are about equal. In profile the first is slightly the more elevated of the two.

Measurements.

	Lines.
Length of ramus from maxillary foramen to incisive alveolus above	5.35
Length of bases of two anterior molars	1.39
" from base of m. 1 to do. of incisor	1.7
" " mental foramen to base of incisor	1.55
Least depth ramus (near mental foramen)	2.
Depth ramus at first tooth	2.6
" " third "	2.4
Width " second"	1.2

These indicate a much stouter form than in the Tamias striatus.* The foramen mentale is lower in position; the series of molars is much less oblique to the axis of the ramus than in the chipmunk, and the incisor tooth is stouter. As compared with the S. hudsonius the measurements are absolutely one third greater, indicating a difference in size of nearly two to one. Viewed from above the thickness of the ramus at the middle in Sc. panolius is proportionately very much less, while at the incisive margin there is less difference; the two measurements being equal in S. panolius, the incisive much narrower in Sc. hudsonius. The first molar in the existing species is narrower outside than inside and simple; in Sc. panolius, equal and emarginate.

This little species has not furnished sufficient materials to indicate its relationships fully; but it is smaller than any true squirrel now inhabiting the United States.

LEPUS SYLVATICUS, *Bachm.*

Numerous molar and incisor teeth from both jaws, and two partially broken rami of the mandible. One of these is broken off behind the third molar; another complete only as far as the usual line of the coronoid process, and containing the second, third and fourth molars. These portions are similar to those of the common species now found throughout the eastern district of North America. Also from Galena; see Leidy l. c. XI, p. 100.

ANOMODON SNYDERI, *Leconte.* Amer. Journ. Sci., 1848, 103. Journ. Ac. Nat. Sci., Phil., III, 171, Tab.

A large and remarkable insectivore known only as yet from an incisor tooth from Galena.

BLARINA, *sp.*

A nearly complete ramus with dentition perfect, of about the size of that of the common B. talpoides was found, but unfortunately mislaid.

* See Baird. U. S Pac. R. R. Expl. VIII. Tab. XLVI. 2 and 1.

VESPERTILIO, *sp.*

Numerous bones of bats occur in the breccia. A portion of maxillary with teeth was preserved, but fractured in the attempt to expose it.

TAPIRUS HAYSII, *Leidy.*

Several inferior maxillary molars. They all have a rather greater anteroposterior diameter than those of the existing Central and South American species.

EQUUS ? COMPLICATUS, *Leidy. E. americanus*, Leidy.

Upper and lower milk and permanent molars.

DICOTYLES NASUTUS, *Leidy.* Proceed. Acad. Nat. Sci., Philada., 1868,

Several molar and canine teeth.

DICOTYLES COMPRESSUS, *Leconte. Platygonus compressus*, Lec., etc. Amer. Journ. Sci., 1848, 102. *Dicotyles*, Leidy, Trans. Am. Soc., XI, p. 97, also X, 324.

Not found by me in Virginia; abundant at Galena and elsewhere.

CARIACUS VIRGINIANUS, *Gray. Cervus*, Bodd.

Molars and other fragments of this species are perhaps the most abundant in the breccia. One posterior portion of ramus mandibuli with tooth in situ is in the collection.

BOS ? ANTIQUUS. *Bison*, Leidy.

Molar teeth.

URSUS AMPLIDENS, *Leidy.* Proceed. Acad. Nat. Sci., 1853.

A single posterior lower molar of this species, identical with that described by Leidy from a ravine near Natchez.

URSUS AMERICANUS, *Linn.* Leidy, Journ. Ac. Nat. Sci., Phila., III, 169.

From various caves; not found by me in Virginia.

PROCYON PRISCUS, *Leconte.* Leidy, Journ. Acad. Nat. Sci., III, 169.

Perhaps the same as the next. From Galena.

PROCYON LOTOR, *Linn.*

A posterior inferior molar, not distinguishable in any point from a specimen from a New Jersey peat swamp, both identical with the common raccoon.

MIXOPHAGUS SPELAEUS.

This animal is represented by a molar tooth, which though somewhat imperfect is so characteristic as to require notice. It appears to have been derived from the lower jaw from the behind position of the sectorial. It resembles the tubercular sectorial of the bear, but is even less acutely tuberculate, and is a little smaller than the same tooth in the raccoon. The surface of the crown exhibits concavities between small pointed cusps. The outer margin is a low ridge of four cusps. In front it rises into a more elevated cusp. Here also the tooth is wider, and presents a wider plane of the crown. Part of the inner margin is here broken away, but a little behind its middle a stronger cusp rises, one-third of the width

within the inner margin. The posterior margin is slightly elevated, and in front of it is another very small cusp, similar to those on the external margin.

The characters are less carnivorous than those in Ursus, and approach remotely the smoothness of Cercoleptes. There are indications of two roots, one of which is broken away. The arc of the base of the crown determines the position of this one, and of the anterior margin of the tooth. The strong anterior tubercle is slightly transverse, and the anterior face near its crest being preserved, indicates the extremity of the crown to have been but little beyond. Hence the following measurements:

	Lines.
Length to crest of transverse tubercle	3.7
Width at median outer tubercle	2.5
Depth crown between roots	1.8
Width of root	1.6

GALERA PERDICIDA,* *Cope, sp. nov.*

This is a small carnivore of the Lutrine group of the Mustelidae, apparently allied to Mephitis and Lutra. It is only represented by a left ramus of the mandible, with dentition complete. Its characters are as follows: Dentition $\frac{?}{3}$, $\frac{?}{1}$, $\frac{?}{3}$, $\frac{?}{2}$. The tubercular molar is relatively as in the allied genera, but without sharp tubercle; the sectorial characterizes the genus as distinct from the two mentioned. The posterior lobe is without the marked internal and external acute tubercle seen in Mephitis, nor the tubercular crest of Lutra, but is rounded and slightly concave. The median crests, inner and outer, are strongly developed, and with the anterior, quite as in Mephitis.

The jaw pertained to an adult individual of smaller size than the common skunk, Mephitis chinga. The bases of the crowns of the first and second premolars, and to the outer side of the canine are surrounded by a well marked cingulum. The length of the crown of the molar is greater in proportion to the length than in the skunk. The axis of the coronoid process is as in it, at right angles to that of the ramus. The latter is straighter on the inferior border than in the skunk, and exhibits a marked difference in the angle being nearly on the same line, and not raised above it, as in the species of American skunks and otters, figured by Baird.

Measurements.

	Lines.
From angle to outer incisive alveolus	15.6
Depth at coronoid	8.
From base condyle to tubercular molar	5.
Length sectorial molar	3.6
Width " "	1.2
Height from basal shoulder	2.
Depth ramus at tubercular	2.7
" " at pm. 2	3.1
Length of crown of canine	3.

*The pedant would write this *perdicicida*.

There are two mental foramina in the specimen, one below the third, the other below the first premolar. The crown of the canine is contracted and curved; slightly flattened on the inner side.

Recapitulation.

Whole number of species	27
Number extinct	14
Genera extinct	5
" of neotropical type	6

Helices are extremely abundant in the matrix, with a few other molluscs. They have been identified for me by my friend, Geo. W. Tryon, as follows:—

Mesodon dentiferus, Binney.
" major, Binn.
" albolabris, Say.
Xolotrema appressa, Say.
Xolotrema palliata, Say.
Stenotrema sp. near hirsuta.
Anculotus carinatus.

Associated were numerous vertebræ of Crotalus and perhaps Tropidonotus, fragments of Trionyx and Cistudo, and Menopoma. Also fragments of a Unio, and the ungueal phalange of a bird of prey. There were no human remains of any kind discovered in the breccia.

A collection of fossils of similar character to the preceding, was obtained by Dr. Samuel Harrison of Easton, Talbot co., Maryland, and is preserved in the cabinet of the Baltimore Academy of Natural Sciences. The specimens were exhumed in the course of excavating for marl on the farm of Lambert Kirby, in Oxford Neck, Talbot County. They consist of a considerable number of fragments of the Elephas americanus, Leidy, with two molars, the tusks, and maxillary, premaxillary and parts of frontal bones. Fragments including parts of antlers, not distinguishable from Cervus canadensis, and Cariacus virginianus; the humerus of a Chelydra not distinguishable from that of C. serpentina and of the largest size the species is known to attain; and a portion of the margin with posterior costal and vertebral bone of Cistudo eurypygia Cope, sp. nov. A molar tooth accompanied the above, which resembles that of the half grown Elephas primigenius or E. columbi, but has not the lateral curvature of the latter.

In the earth on the floors of the caves which abound in the lime-stone region of South Western Virginia, the remains of the existing Mammalia of the country may always be found. I have procured Lynx, Vulpes, Procyon, Cariacus, Didelphys, etc. In one chamber the fresh food, apparently of a raccoon, was found, consisting of fresh hazel nuts, wild plum, choke cherry, chicken grapes, acorn, etc. In many, human remains occur, with beads, needles of bone, etc.

In Erhardt's Cave, Montgomery County, Virginia, the writer found four or five specimens of a new Anophthalmus, the A. pusio of Horn, at a

distance of not more than three hundred feet from its mouth. The species is small, and all were found together under a stone. Their movements were slow, in considerable contrast to the activity of ordinary Carabidæ.

Myriapoda are the only articulates which can be readily found in the remote regions of the caves, and they are not very common in a living state. I append a list of these, with their congeners of the outer world, which I collected in the mountainous region. Many of them have been kindly named for one by my friend Dr. H. C. Wood, the author of the Monograph on the American species.

SCOLOPENDRIDÆ.

OPISTHEMEGA POSTICA, Wood, Journ. Acad. Nat. Sci.

This species, or a variety of it with the posterior pair of limbs considerably stouter than the specimens from North Carolina, described and figured by Wood, is one of the most abundant species in the mountains of southwestern Virginia. It occurs every where under stones, etc., and is very active. Its great peculiarity is the modification of the posterior pair of limbs into a pair of stout jaw-like members, which like the anterior jaws are used in offence and defense. They seize the finger with them easily, and penetrate the skin with their sharp chitinous points, though not as effectively as with the jaws. Thus armed at both extremities, they are even less pleasantly handled than the Scolopocryptops sexspinosa, which is also common in the same country. An undescribed Scolopocryptops, with a green body and reddish head, is also common.

LYSIOPETALIDÆ. *Wood, defin.*

The genera of this family appear to the writer to be two, defined as follows:

Annuli without pores. SPIROSTREPHON.

Annuli with two pores on each side the median line. PSEUDOTREMIA G. N.

SPIROSTREPHON LACTARIUS, Brandt, Wood Monograph Myriapoda N. A., 192, *Julis lactarius*, Say.

Not uncommon.

PSEUDOTREMIA CAVERNARUM, *Cope, sp. nov.*

This animal inhabits the deepest recesses of the numerous caves which abound in Southern Virginia, as far as human steps can penetrate. I have not seen it near their mouths, though its eyes are not undeveloped, or smaller than those of many living in the forest. Judging from its remains, which one finds under stones, it is an abundant species, though rarely seen by the dim light of a candle even after considerable search. Five specimens only were procured from about a dozen caves.

Segments twenty-nine, without dorsal keel or groove, but quite convex in antero-posterior section, and somewhat swollen at a dorso-lateral point, forming a slight shoulder and slightly quadrate transverse section. The shoulder becomes much stronger on a few anterior segments. Surface of the annulus rugose, above most so on the shoulders; laterally to the legs

longitudinally (with the axis) coarsely many striate. Posterior annuli but slightly compressed, the last unarmed. Diameter of anterior segments rapidly decreasing to the head. Lateral pores not distinct on anterior segments. An impressed line crosses the latter at the inner lateral pore. Basilar segment smooth, not emarginate in front. Front sparsely hairy; lateral region rather prolonged, openly emarginate. The antennæ as in the other known American species of this family, are elongate and hairy, the relative lengths of the joints being: third longest, 3, 5, 4, 2, 7, 8, 1. Eyes in well developed triangular patches in depressions behind the antennæ.

Length 11 lines; diameter 1.1 line; segments of specimens of considerably larger size, while two taken in copulâ were rather smaller. Color varying from a nearly white to a pale red.

Taken in Erhart's Cave, Montgomery Co., and Spruce Run and Big Stony Creek caves, in Giles Co.

PSEUDOTREMIA VUDII, *Cope, sp. nov.*

This species differs much from the last, and resembles rather P. caesioannulatus of Wood. The points separating it from the latter will be pointed out below.

Number of segments same as in the B. cavernarum, twenty-nine, but they are neither convex nor rugose nor coarsely striate, but marked with a very minute, irregular longitudinal striation. Segments cylindric, without shoulder, but with a small point directed backwards on the posterior margin of the lower part of the annulus, which is enlarged on the front segments. This elevation is furnished on the anterior and posterior regions, and probably everywhere, in an uninjured condition, with a bristle. On the anterior segments a hair in front of each pore. Front plane, with finer and coarser hairs sparsely distributed. Labral margin with an open notch. Antennæ hairy, with a bristle at the distal extremity of each joint. Lengths, 3rd, 5th, 4th, 2nd, 8th, 7th, 1st; the eighth joint longer than in A. cavernarum. Eye patch triangular, not in a depression. Posterior segments considerably compressed, the last scutum with four transparent marginal bristles; extremity of body slightly recurved. Total length, eleven lines.

Color pinkish-brown, with a pale band from below to the external pore on each side of each annulus. Top of head black.

A single specimen, the exact locality not preserved, but probably Montgomery Co., and, I think, not from a cave. I have conferred on it the name of my friend Dr. H. C. Wood, Jr., to whom we are indebted for a system of the Myriapoda, and the means of studying the American species. It differs from the A. caesioannulatus of his monograph, in the rounded dorsum without keel or groove, the 29 instead of 32 segments, and the coloration. The eye patches are not in a depression, nor is the labrum deeply emarginate, as Wood describes.

JULIDAE.

SPIROBOLUS AGILIS, *Cope, sp. nov.*

This is the pigmy of the genus, and is not less distinguished by the small number of its segments, and the greater activity of its movements. The short antennae, and anteriorly produced second segment, are precisely those of other species of the genus.

Segments thirty-eight, smooth above, but with delicate, irregular longitudinal striae below. Front higher than wide, smooth, not punctate, but with a faint trace of median groove. Two rows of hairs on and above the labral margin. Bristles of the legs weak. Preanal plate transverse narrow elliptic. Antennæ sparsely hairy. Total length, eight lines. Color, wood-brown, with a reddish posterior marginal band to each segment; front and antennæ pink.

Giles County, Va.

CAMBALA ANNULATA Cope, *Julus annulatus* Say, J. A. N. S., 1st, II., 103. *Spirostrephon* Newport, Wood. ?"*Julus lactarius* Say" Gray et Newport not of Say. *Cambala lactaria* Gray and Newport.

Gervais and Wood have pointed out the error of Gray and Newport in regarding this animal as the the *J. lactarius* Say, but have not suspected that it is the *J. annulatus* of the same author. The species is quite rare, as I have seen but one specimen, which I took in the Spruce Run Cave on the Kanawha River, in Giles Co., Va. It has considerable superficial resemblance to the *Spirostrephon lactarius*, and is one of our most elegant Myrapoda. In generic characters it has the second annulus of Julus, and the short thick antennæ of Spirobolus, but adds a speciality in the almost obliteration of the visual organs. These are reduced to a single linear series of not very distinct occelli immediately adjoining the margin of the basilar segment on each side.

Segments sixty-one; color deep mahogany brown above. Total length 2 in. 2 lin.

Say's description applies exactly to our specimen. It would not be safe to insist that this is the *Cambala lactaria* of Newport, but it most probably belongs to the same genus, characterized by linear eye-patches.

JULUS MONTANUS, Cope, *sp. nov.*

This species is in most respects similar to the J. pennsylvanicus as given by Wood. There are two impressions on the vertex; the antennae are elongate; the last scutum is prolonged into a moderate straight mucro, and the posterior segments are quite pilose. The color is a dark brown with a series of blackish dots on each side. It differs from J. pennsylvanicus solely, so far as can be ascertained, in having 69 instead of 63 segments, and in the median portions of the same being smooth, and the inferior portions closely many grooved, instead of having "above punctae which give rise to obsolete grooves," Wood.

Mountains of Giles and Montgomery Counties.

POLYDESMIDÆ, Latr.

POLYDESMUS VIRGINICUS.

POLYDESMUS CORRUGATUS, *Wood.*

ANDROGNATHIDÆ, *Fam. nov.*

A group intermediate between the suborders Strongylia and Sugentia. Characters. The labium a broad slightly cordate plate, extending beneath the consolidated elements of the front, and having a slight membranous marginal attachment externally, leaving a small oval orifice at the anterior extremity. The mandibles rudimental, extremely minute, far within the margin of the inferior face of the head, composed apparently of two segments. Segments of the body consolidated. Preanal segment an uninterrupted cylinder.

ANDROGNATHUS,* *Cope, genus novum.*

Char.—Joints of the antennae five, the sixth and seventh confluent, and with the closely joined fifth, forming a club, supported by the short proximal joints; segments of the body numerous, (over fifty in the only species,) muzzle short.

This singular genus is one of the hitherto unknown forms connecting the suctorial group of Myriapoda with the mandibulate. It furnishes a clue also to the structure of the suctorial mouth of the former group, which appears to have been as yet unexplained. Thus we see that the mandibles disappear, and the labium extends, and uniting by its margins on either side leaves the mouth a transverse fissure. With a further union of the mandibles with a prolonged labrum on each side, we would have a form of Sugentia, perhaps like Brachycybe of Wood, between which and the Polydesmidae the present genus stands. Like many of the members of the latter family, this one occurs under bark of decaying logs, though its food is more probably of a soft character, as the decomposing fungi often found in such situations or the bodies of dead insects and molluscs.

ANDROGNATHUS CORTICARIUS, *Cope, sp. nov.*

This is a rather slender and cylindric species with fifty-six segments, having rather short, strong, lateral laminae projecting abruptly from all except the anal. The dorsal portion of the segment is convex above the lamina, but less so than the ventral. The anterior laminae are transverse but the majority have an oblique anterior truncation. Non sheathing part of each segment slightly convex, and divided on the median line by a groove, within which runs a delicate thread or bead, which is raised on the lower part of the segment, and extends throughout the length. Upper surface of segment also divided transversely by one annular groove, the raised portions being minutely rugose. The same rugosity exists below the laminae. The anterior shields and laminae at least, have a fine pubescence. The antennae and front are densely pubescent. Labral margin flat, not emarginate. The muzzle is not so long as the antennae, and less contracted than in Wood's figure of Brachycybe. Anal annulus elongate, smooth, truncate, enclosing the short lateral anal plates. Length nine lines; proportions slender. Color in life, a very pale yellowish brown, lighter below.

From Montgomery County, Virginia.

* $\alpha\nu\eta\rho$ man, $\gamma\nu\alpha\theta o\varsigma$ jaw.

II. Description of two large extinct rodents from Anguilla, West Indies, with remains of human art associated.

AMBLYRHIZA, *Cope.*

Molars curved prismatic, rootless, some composed of four, others of five dentinal columns, separated by more or less transverse plane laminae of enamel; the whole enclosed in a sheath of cementum. The fangs contracted, closing one or more of the dentinal columns at the base. Triturating surfaces plane, subquadrate, or subtrigonal. Incisors narrow, with very small pulp cavity for much of the length; anterior plane transverse, the enamel equally folded in a narrow band on the inner and outer faces. Digits subungulate.

The characters of the genus ally these animals to the Chinchillae, and do not present more than a small number of differences, though important ones. Thus the closure of the dentinal columns below, indicates either a limit to the formation and protrusion of teeth of the same degree of complication, or the entire termination of such process, as in the root bearing types. It presents in fact an interesting transition between the monophyodont and diphyodont structures. There are two extinct genera related to the Chinchillae, with which the present may be compared; Archaeomys Laiz. Par. and Megamys D'orb. The first is said only to differ from Lagidium in the presence of an additional dentinal column, so that the form of the root is to be presumed to be the same; it therefore differs from Amblyrhiza in that respect, as well as in having the dentinal columns $\frac{4}{3}$ instead of $\frac{5}{4}$. The known species are from the fresh-water limestone of Allier, France. Megamys patagoniensis is only known from a tibia and rotula, and its dental characters are therefore not ascertainable. I cannot refer the present animal to that genus with any probability. The species is much larger than that described by D'orbigny.

AMBLYRHIZA INUNDATA, *Cope.* Proceed. Acad. Nat. Sci., Philada., 1868, p. 313.

The remains of this large rodent were found in a mass of breccia, which was thrown out in the excavations made in a cavern in the small Island of Anguilla, W. I. The remains occurring in that most eastern region of the West Indian Zoological district, might be anticipated to have a special interest in connection with the history of the submergence of a once great continent. With this impression, the writer examined a quantity of the above breccia and cave deposit, which was brought to Philadelphia as a probably available phosphatic manure. It was found to be valueless for this purpose, and the only result of the outlay was the discovery of the Amblyrhiza. Most of the fragments were dressed from a single block. There were in this the extremity of a right femur with patella, shafts of various long bones, fragments of pelvis and maxillary bones, with three molars, and two partially complete, and other much broken incisors. The teeth were scattered among the bones, and are so related in size to most of them, as to induce the belief that they all belong to the same animal. This is strengthened by the occurrence of the

distal portion of the right femur of another individual in another mass, and the entire absence of bones or fragments which could be referred to any other animal. In the matrix occurred Turbo pica L., whereby the postpliocene age of the deposit is to be inferred.

The molars belong to an animal of the average size of the Castoroides chiensis Foster, and as the epiphysis of the femur is not yet coössified, and the animal is young, I have no doubt, the proportions of the species are quite equal to those of the beforementioned largest of known Rodentia. This is confirmed by the proportions of the femora, whose shaft and condyles are larger than those of the ♀ Cervus elaphus of four years old, with which I have compared it. What the bulk may have been, is difficult to infer without additional portions of the skeleton, but it is sufficiently obvious that this ancient chinchilla exceeded the Virginian deer, and more than equalled the American Black Bear in this respect.

Three molars are preserved, two of which present four dental columns, and one three. These columns are transverse, the first, which I assume to be anterior, transverse; the second the longest, the third shortened inwardly, and slightly curved round the very small fourth, which occupies a posterior-external angle of the crown. All are separated by rather thick enamel laminæ. The form of the crown of the largest presents two sides of a square anteriorly and externally, the inner side bilobed in correspondence with the two anterior columns; the posterior strongly convex backwards and outwards. The other, similar molar, differs in the posterior outline being more nearly transverse, and the anterior outlines being united by a continuous curve. The large portion of the third tooth preserved is perhaps the external; it is a part of a nearly regular transverse oval.

The first described molar is strongly curved posteriorly, and its diameter narrows regularly to the contracted base; there is a shallow groove at the junction of the anterior enamel lamina with the inner wall. This groove is much more strongly marked in the second described, but ceases before attaining the contracted extremity. The shank of the tooth is less curved than in the other. The contraction is less graduál than in the first, but is strongly marked at the base, where the pulp cavity is not wider than one of the columns.

	Lines.
Length anterior face No. 1 (on curve)	14.3
Diameter crown (longitudinal)	6.
" " (transverse)	5.7
" root (longitudinal)	4.
Length anterior face No. 2	14.3
Diameter shank (longitudinal)	6.
" " (transverse)	5.

A portion of one of the inferior incisors of some forty-six lines in length, and another shorter piece, furnish characters of the species and genus. The inner face of the tooth is plane, and at right angles to the anterior; the outer is rounded obliquely inwards; the inner face is broad and not

prolonged ; the curve of the tooth is in one plane, and the depth is about equal to the width. A narrow fold of the enamel embraces the anterior border of the inner and outer faces ; it is folded back at a right angle within and with a truncate angle without. The enamel is sculptured into numerous close, fine longitudinal grooves, which do not inosculate. The separating ridges number 14 near the middle of the tooth, those near the borders being the strongest. One, strongest of all, is on the external turn of the enamel, and near it numerous interrupted ridges have a slightly oblique direction.

The incisors are, as in the modern representatives of the Amblyrhiza, of more slender proportions than in the beavers, Arctomys, and other rodents, and their extinct predecessors. They are, also, relatively less stout than those of the Castoroides. Their sculpture is quite similar to that seen in the Lagidium and other chinchillas.

	Lines.
Width anteriorly	6.
Depth	5.7

Having requested Dr. Rijgersma to make further search in the localities where the preceding specimens were obtained, that gentleman made a special trip to Anguilla, and made a successful search among the debris and in the caves, whence the supposed phosphatic earth had been excavated. He found a considerable number of bones and five additional molars of Amblyrhiza ; also seven molars referred below to a distinct and allied genus (Loxomylus Cope) with numerous incisor teeth belonging to both genera.

Two adjacent molars of the first named, are in excellent preservation, and the posterior displays one dentinal column more than any other tooth ; it is, therefore, probably the posterior superior. They all display the curved shank and plane crown and contracted root already described. A portion of a superior incisor measures 1.35 mm. in transverse diameter, and 1.4 mm. in depth.

A distal phalange (figured) displays clearly the subungulate character of the genus, in its straight shaft and depressed, truncate extremity. It was found with a few of the teeth and other bones of this species, which are distinguished from the others by their bright red color.

On a third examination of the locality Dr. Rijgersma found some masses of breccia, in one of which is enclosed a very fine superior incisor of the left side, probably belonging to this species. Both extremities are broken off, but the remaining fragment measures 7 in. 5 lin. in length; the width of the anterior or enamel covered face is nearly eight lines, and the depth eleven lines; the latter measurement somewhat increased by the partial crushing of the shaft. The enamel exhibits the usual longitudinal ridges, but there are two stronger a little within the external margin, and another strongly marked, a quarter inch within the inner margin. This tooth indicates an animal as large as the largest known Castoroides, for though the incisors of some of the latter slightly exceed those of the present animal, these teeth have a larger proportion to the general bulk in Castoroides than in Amblyrhiza.

The extremity of the femur is remarkably broad and depressed; it expands a little at the condyles. The trochlear groove is but little raised above the plane of the anterior (superior) face of the femur, while its lateral bounding ridges are strong, the inner the more prominent. The width of the groove is about equal to the transverse diameter of the tuberosity on the inner side, and greater than that of the outer. The faces of the condyles are quite inferior, and sub-depressed, the outer extending rather more posteriorly than the inner. Both are so separate from the trochlear groove as not to have had any continuous face with it; this is not entirely clear, as the surface is slightly injured at the point of connection. The inter-condyloid fossa is continuous both with the inferior face of the femur, and with the trochlear groove, without separating ridges, as many rodents exhibit. Just above the inner condyle there is a strongly marked fossa of a regularly rounded form.

The general character of the two femora confirms those of the teeth, as of a large rodent. The form and relations of the articular faces differ alike from those exhibited by Carnivores, Ungulates and Edentates. The patella, which pertains to one of the femora, is an elongate bone, with thinned and rounded distal extremity. The proximal portion is lost, but at the fracture the section is very convex. More distally it is flat.

	In.	Lin.
Width femur just above condyles	2	3.7
Depth " " "		14.
Width at tuberosities	3	4.8
" trochlear groove, distally		16.
" inner condyle		14.2
" outer "		18.
" intercondyloid fossa		7.
Length fragment patella	2	6.
Width at middle "		14 6
Depth at fracture		10.4

LOXOMYLUS, *Cope.*

Molars straight, prismatic, composed of three dentinal columns, one of which is incurved, but none closed at the base. The triturating surface very oblique in the vertical direction, indicating the greater elevation of the teeth at one extremity of the series than the other. A horizontal obliquity of the dentinal columns is produced by their lateral displacement. Enamel plates but slightly curved. An external cementum layer.

This genus differs in many points from Amblyrhiza; these are, the lack of one and two dentinal columns; the double obliquity of the crowns, the absence of curvature, and less closure of the base. It is nearer to Archaeomys Laiz. et Par., but differs in two points; that the upper molars have but three dentinal columns like the lower, instead of four, and that the horizontal grinding surface is oblique. This last peculiarity alone seems to distinguish it from Lagidium and Chinchilla, indicating a relation to the latter similar to that between the great extinct beaver of Europe Trogontherium cuvieri, and the existing genus Castor.

LOXOMYLUS LONGIDENS, *Cope.*

This large rodent is represented by seven molar teeth and probably some incisors and bones of the skeleton; all except one tooth in the collection made by Dr. H. E. Van Rijgersma in the caves, and cave breccia taken from the caves in the island of Anguilla, West Indies.

I cannot distinguish the incisors as belonging to this species, and they are probably identical in character with those of the Amblyrhiza inundata, as is generally the case with nearly allied genera and species of Rodents.

A section of all except the terminal teeth is an oblique rhomboid, the longitudinal diameter being but little greater than the transverse. A single terminal tooth (either superior posterior or anterior inferior), is narrowed in the terminal column. All the teeth possess one longitudinal groove on one side and two on the other, which are covered but not obliterated by the cement layer. The teeth, though much straighter and more slender than those of Amblyrhiza, yet possess a light lateral, though no antero-posterior curvature; those of the upper and lower series curving in opposite directions.

	Inches.
Length of a median molar	1.7
Antero-posterior diameter (oblique)	.52
Transverse " (both of crown)	.43
" " terminal molar	.39
Longitudinal " " "	.56

One tooth of this species was taken from a mass containing molars and incisors of A. inundata, and the species is without doubt of identical age with it. Its molars indicate a less robust animal, but I find no incisors which indicate an animal of generally small size. An inferior incisor to which adheres a portion of a molar apparently of this species, is not distinguishable from that of the A. inundata. It measures .11 in. in length and .012 in width anteriorly. This species was probably as large as but more slender than the Amplyrhiza.

The Island of Anguilla could not readily have supported a fauna of which these huge rodents formed a part. Such large animals have no doubt ranged over a more extended territory. This, and other facts mentioned by Pomel, lend probability to the hypothesis of the latter author, that the submergence of the ranges connecting many of the Islands of the Antilles has taken place subsequent to Pliocene times.

Associated with the preceding remains, Dr. Rijgersma discovered a highly interesting relic of the stone age of the human inhabitants of this portion of the West Indian Islands. I use the term stone age in a chronological sense only, since the region in question possess chiefly coral rock, and little or none that is adapted for conversion into cutting instruments, so that the inhabitants resorted to the use of animal products, as teeth, bones and shells. The implement found by Dr. Rijgersma is a long ovate spoon-shaped scraper or knife, cut by human hands from the lip of the large Strombus gigas. The ribs of the external surface and the smooth

internal surface are easily distinguished, and the distinct natures of the lamellar and prismatic layers have been evidently well understood by the artificer, who has ground away the latter in order to put a sharp edge on the former at one end. This edge is sharp, and mainly well preserved. The implement has a greater median width, and smoothly ground thick margin; the end of the plate is obtuse and with thick edge, almost entirely composed of the prismatic layer. It has evidently been held in the hand, and been used after the manner of the stone chisels of the North American Indians.

The cotemporaneity of man with postpliocene Mammalia in Europe and North America may be considered as established. It is, however, an important question to decide whether man occupied successively regions more and more remote from a supposed place of origin by migration, or whether a cotemporary postpliocene existence can be traced over the whole earth. His remains were not found by Lund after remarkable and extensive investigations into the postpliocene cave fauna of Brazil, though human remains from caves not far from Rio Janeiro, are in the Academy's Museum. What the precise age of these is, cannot now perhaps be stated. On the Peninsula of Florida Prof. Wyman has found remains of Man, but not associated so far as I can ascertain with any extinct species of Mammalia.

The present shell-chisel was found by Rijgersma under circumstances precisely similar to those attending the discovery of the gigantic rodents. Some portions of each of the species described were embedded in the breccia, and others occurred loose in a red earth in cavities of the breccia. The chisel has the color and constitution of the latter teeth and bones, and was found with them in this earth. Some of the teeth are even more fresh looking and less stained than the chisel. Though the evidence is not quite conclusive, yet the inference is very strong that the Amblyrhiza and Loxomylus had human cotemporaries.

If now these large herbivorous animals lived before the submergence of the mountains, whose peaks the present Virgin and other West Indian Islands are, we are enabled, with due regard to the slenderness of the evidence, to suggest human co-existence with that great geological event. A probability is thus added in favor of the lateness of the period of submergence of a former Caribbean continent, as already suggested by Pomel.

III. On two extinct Marine Mammalia from the United States.

ANOPLONASSA, *Cope.*

This genus is represented by a considerable portion of the mandible. No other fragment has as yet come under my observation. The portion does not extend posterior to the symphysis, but the latter is very long, and the rami slender, indicating a form of muzzle quite like that of a gavial or a Squalodon. It is strikingly different from the latter genus in being for the most part edentulous. The foramina of the dental arteries issue numerously along the outer margin of the superior face of the ramus, and are more or less connected by a longitudinal groove. Shallow

alveoli for two representatives of teeth on each side, indicate a peculiar character of the genus. The two largest alveoli occupy the extremity of the symphysis, looking upwards and forwards. They are closely approximated, and are together wider than the mandible immediately behind them, which expands to support them. They are shallow, with rugose floor, which is somewhat elevated medially, and perforated by numerous nutritious foramina. The other alveolæ are nearly twice the middle of the mandible behind the anterior pair. They are much smaller than the latter, and equally shallow, and of a longitudinal ovate form; the fundus is rugose, not elevated, and furnished with nutritious foramina, which are smaller than those of the edentulous gum.

That true teeth occupied these positions, appears to me doubtful, from their shallowness, and small foramina. I rather suppose them to have been knobs or bosses, possibly corneous in structure. The edges of the mandible resemble those of such edentulous Cetacea as Hyperaodon and Xiphius, and indicate not very distant relationships to tooth bearing types. The mental foramina are large and subdivided, so that the largest and posterior opening is inferior, the superior anterior.

The affinities of this very curious genus appear to be in a general way with the aberrant Cetacea. The nearest types appear to be on the one hand Sirenia, and on the other, Squalodon. How remote it may be from either, it is difficult to state; of approximation to either little can be said. Should the posterior part of the ramus exhibit teeth, their character would indicate its Sirenian or Cynorcoid relationships. We can now only indefinitely regard it as a shore loving Cetacean, with a long slender beak, which it must have used much as nippers, perhaps probing mud or deep cavities, but for what kind of food it is difficult to imagine.

ANOPLONASSA FORCIPATA, *Cope.*

The length of the portion of the mandible described is seven inches, six lines. The transverse diameter differs very little to a point half way between the alveolæ, where it is gently contracted; it is then slightly expanded, and presents an obtusely projecting outline at the extremity. In profile the symphyseal extremity curves gently upwards from the point where it first contracts, so that the ridge separating the alveolæ is quite elevated. In transverse section the fragment is almost practically an isosceles spherical triangle, with a straight superior side. The superior face is however slightly convex in section, and a little elevated above the dental grooves on each side. There is a slight groove on each side of the symphysis below, which becomes very strongly marked distally. They diverge and continue to the extremity through the mental foramina, and reaching the upper surface nearly meet again. They enclose a strong symphyseal ridge, which is distally divided by a groove.

Measurements.

	m.
Length of fragment	.1920
" to second alveolus	.0735
" of " "	.0140
" of first "	.0240

Width	distally	.0325
"	least	.0270
"	proximally	.0320
"	of distal alveolus	.02
"	of second "	.65

This species was found with a number of rolled fragments of Mastodon not far from Savannah, Georgia. The specimen is silicified, is dense and heavy, and slightly worn. Its color is black, and it resembles in all respects the remains of the Mastodon accompanying. It is preserved in the Museum of Comparative Zoology, Cambridge, Mass., and was lent me for examination by Prof. Agassiz, the director.

HEMICAULODON, *Cope.*

This genus is established on a right upper incisor of a large Sirenian Mammal allied to the Dugong.

The form of the tooth is that of a compressed, slightly curved cylinder, with distal and proximal vertical diameters equal. There are two open grooves on the inner and one similar on the outer side, the former enclosing a broad bead. The transverse diameter posteriorly is less than that anteriorly. The substance of the tooth is composed of a large axis of osteo-dentine surrounded by a broad cylinder of dentine, which is in turn surrounded by a thick stratum of cementum. The dentine is marked at regular distances by annuliform ridges, which are more or less undulate. They become gradually more distant distally. These ridges can be traced through the cementum. The cementum is everywhere entire, and is thicker distally. It presents externally a few longitudinal grooves at irregular distances, and numerous fine striæ irregularly disposed.

The pulp cavity is small and compressed; how far it extends into the shaft is uncertain, as it is choked by hard debris; but at the lowest point it is much contracted and sublinear. But a portion of the triturating surface is preserved; it truncates the tooth upwards and backwards in relation to its axis, as would be anticipated in a superior incisor.

The characters of this genus ally it to Halicore and Rhytiodus Lartet. In Trichechodon Lankester, the dentine does not present the external transverse ribs; the same character distinguishes it from Halitherium Kaup; in both these genera there is a distal acumination not visible in Hemicaulodon. Ontocetus Leidy from the Miocene of North Carolina, which I suppose to be a large Sirenian allied to Halicore, presents very weak and approximate dentinal ridges on part of its surface. It differs from this genus in the acuminate form of the tooth, and it probably presented a conic apex as in Trichechodon.

The comparison with its nearest allies is as follows. Both Halicore and Rhytiodus have the upper incisors dilated and flattened distally, and with a narrow oblique triturating surface. This extremity is, according to Owen, the only portion of the tooth which is exposed beyond the gum. In the present genus no such expansion exists so far as observed, and the truncation and exposure of the tooth, takes place at a point which would correspond to the basal third of the fang in those genera. In the latter

this point is deep within the alveolus. It is therefore much shorter, even supposing its extremity to have been broken off, and worn on the fractured surface. Both the above genera possess a layer of enamel on the external, and a sheath of cementum on the internal side; in this genus there is a thick sheath of cementum all round. The plane of the worn surface is in Halicore oblique to the short diameter of the shaft of the tooth (see Lartet on Rhytiodus, Bull. de la Soc. Geol. de France, 1866, Pl. XIII), while in the present species it is oblique to the long diameter.

HEMICAULODON EFFODIENS, *Cope sp. nov.*

The transverse diameter of this tooth is greater anteriorly than posteriorly. The ribs of the dentine are strongly marked and distant. The dentinal layer is about one half the thickness of the osteodental axis, and three times that of the cementum.

	Metres.
Greatest length of specimen	.015 .00
" diameter	.007 .40
Least "	.004 .50

The external surface of the cement is slightly rugose from interruptions of striæ. The widths of the tooth increase very little from the basis to the worn surface.

The only specimen of this remarkable species which I have yet seen is considerably larger than the corresponding portion of the Indian Dugong. It was first brought to notice by Dr. Samuel Lockwood, of Keyport, Monmouth co., N. J., who obtained it from the Eocene marl pits at Shark River, Monmouth co.

EXPLANATION OF THE PLATES.

PLATE III.

Fig. 1.—1 a. Galera perdicida, Cope.

" 2.—2 a. Mixophagus spelaeus, Cope, double nat. size.

" 3.—3 a. Sterodectes tortus, Cope, external and posterior views of superior incisor.

Fig. 4.—Tamias laevidens, Cope, double nat. size.

" 5.—Sciurus panolius, Cope, 5 a, right ramus of mandible from above; both double nat. size.

Fig. 6.—Tapirus haysii, Leidy, inferior molar; 6 a, another inferior molar, from above.

The above are of the natural size, except where stated otherwise.

PLATE IV.

Fig. 1.—1 a. Amblyrhiza inundata, Cope, inferior incisor; 1 a, from the outside; nat. size.

Fig. 2.—Do. molar, from behind; 2 a, crown, grinding surface, nat size.

" 3.—Do. two posterior superior molars from the side; 3 a, grinding surface; nat size; 3 b, root of do. from behind.

Fig. 4.—Do. right femur, from above; 4 a, distal end of same, slightly restored from specimen of fig. 5. One half nat. size.

Fig. 5.—Do. right femur of second individual from the outer side; one half nat. size.

PLATE V.

Fig. 1.—Amblyrhiza inundata, distal phalange, lateral view; 1 a, anterior view.

Fig. 2.—Leptomylus longidens, Cope, two molars, lateral view; 2 a, crowns of do.

Fig. 3.—Leptomylus or Amblyrhiza, premaxillary teeth and bones from below, showing incisive foramen.

Fig. 4.—Human implement made from Strombus gigas., 4 a, lateral view.

Fig. 5.—Anoplonassa forcipata, Cope, mandible from above; a, from the side.

Fig. 6.—Hemicaulodon effodiens, Cope, incisor from the side; a, triturating surface.

Stated Meeting, August 20, 1869.

Present, four members.

JUDGE LOWRIE, in the Chair.

A letter from Prof. Coppeé announced the return of Marianna's History of Spain.

A letter from the President nominated Dr. Bell to prepare an obituary notice of Dr. Meigs, deceased.

A letter from Dr. Leidy accompanied a donation of three highly ornamented Ojibwa pipes to the Museum of the Society by Mr. Clark.

A letter from the Mayor of the XVI Arrondissement of Paris requested a donation of the Publications of the Society for a Public Library in that precinct.

Letters of acknowledgment were received from the Society at Moscow, April, 1869, for Proceedings No. 77; the Vienna Academy, XIII. ii. 73–77; Society at Rome, 77; at Bordeaux, March 12, 76, 77; Lisbon Academy, March 28, 1868, List. Catalogue, I.; B. N. H. S., 78, 79, 80; Am. Ant. Soc., XIII. iii.; R. Island Soc., 81; Yale Coll., 81; Wisconsin H. S., 81.

A letter circular from the President of the Congrès International d' Archéologic Préhistorique à Copenhagen, 27 Aout, 1869, date March 1, 1869, was read.

Donations for the Library were announced from the Observatories of Turin, Dorpat and Prag; the Academies and Geological Societies of Berlin and Vienna; the Natural History Societies at Bonn, Harlem, Bordeaux, Montreal, Salem and Philadelphia; the Antiquarian and Historical Societies at Copenhagen and Worcester; the Oriental S. at New Haven; the London Meteorological, Chemical and Zoological Societies; Sir James Clarke, Charles Ritter d' Elvert of Brünn; Prof. C. H. Hitchcock, Dr. S. D. Gross, the Surgeon General U. S., and the Public Library of Cincinnati.

The death of Prof. Cleveland, in Philadelphia, August 18, aged 67, was announced by Prof. Trego.

And the Society was adjourned.

Stated Meeting, Sept. 17, 1869.

Present, seven members.

Mr. Fraley, Vice-President, in the Chair.

A letter accepting membership was received from Joseph D. Hooker, dated Royal Gardens, Kew, July 12th, 1869.

Letters acknowledging receipt of Transactions XIII. 3, were received from the Boston Pub. Lib.; Mass. Hist. Soc.; Harvard, Yale, and Amherst College Libraries; New York Hist. S., Hospital, and State Library.

Letters acknowledging receipt of Proc. 81, were received from the Essex Inst.; Boston Pub. Lib.; N. Y. Hist. Soc., and Cincinnati Observatory.

A letter from M. Carlier to Mr. Durand was read, promising the official documents in the matter of the Michaux Legacy to be forwarded by the hands of Mr. Biddle now in Europe. All the forms of French law are now satisfied, and M. Germain of Pontoise has given M. Carlier a receipt in full of all demands in settlement of fees.

Mr. Price, after remarks explanatory of Michaux's known tastes and intentions, offered the following:

Resolved, That the Committee on the Michaux Legacy be authorized

to make inquiry whether the trust under the will of André Francis Michaux may not be executed in whole or in part within the Fairmount Park; with authority to communicate with the Commissioners of the Park upon the subject; and to make report to the Society.

The resolution was agreed to.

A letter from Mr. Sullivant to Mr. James was read, referring to the discovery of a posthumous work by Schwarz the bryologist. On motion, permission was granted to Mr. James to select from the Muhlenberg herbarium certain mosses for Mr. Sullivant to examine, in reference to Schwarz's determinations, to be returned to their places in the herbarium.

Donations for the Library were received from the Berlin Academy, Teyler Museum, Paris Geographical and London R. Astronomical Societies, Mr. Scudder at Boston, Silliman's Journal, the Franklin Institute and the Medical News.

"The Arawak Language of Guiana in its Linguistic and Ethnological Relations," by D. G. Brinton, M. D., was offered for publication in the Transactions, and referred to a committee consisting of Mr. Lesley, Mr. Chase, and Mr. Haldeman.

"A second addition to the History of the Fishes of the Cretaceous of the United States, by Edward D. Cope," without illustrations, was read by title and referred to the Board of Secretaries.

"The maintaining Forces of Cosmical Motions," was the title of a paper read before the Society, by Judge Lowrie; a discussion ensued in which Mr. Price, Mr. Lesley and Mr. Fraley took part. Mr. Lesley dissented from the opinions expressed in the paper, so far as any claim was set up to a discovery calculated to effect a radical change in the accepted methods of regarding planetary motion.

Mr. Marsh described the peculiarities of the Meteor of August 24th, and others, belonging as he suspected to a group passing the earth during the day time in the United States, and therefore only the last of which became visible at or after sundown.

Pending nominations Nos. 227 to 640, and new nominations 641, 642, were read. And the Society was adjourned.

SOME SUGGESTIONS ON THE MAINTAINING FORCES OF COSMICAL MOTION.

By Walter H. Lowrie.

I desire to submit for consideration some suggestions tending to the production of a true theory of the force by which the revolutions of the planets are maintained against the tendency of attraction to draw all bodies to a common centre, or a solution of what Sir John Herschel calls "the theorem" of the conservation of the *vis viva* of cosmical motion.

I know of none hitherto received except that composed of the postulate of an original impulse and the law of inertia: that a body set in motion by a single impulse and out of relation with other bodies moves forever with its initial velocity and direction. Such a proposition is evidently not a product of induction, for no body was ever known to be in such a case or to move thus; and therefore it defines no actual class of motions whatever, as every physical law ought to do. Indeed philosophy never treats of things out of their relations. This is, therefore, a mere metaphysical idea, meaning only this, that, in the investigation of motions so as to find their system, the mind demands a cause for every change in their degree or direction.

It very properly assumes an original propulsion; because motion exists, and its origin could not possibly be a matter of human observation. But the theory founded on this law goes beyond the law, and treats of bodies that are *in* relation with each other, and then assumes, that, by reason of this relation, that is, by the attraction of a primary body upon its secondary, motion may be changed in direction without being changed in degree; and thus, according to it, the original propulsion is the true motive power of all cosmical systems, while the only function of attraction is to deflect tangential into elliptical motion and hold it there.

Now this theory is both logically and philosophically vicious; because it takes our idea of absolute motion and uses it as a true expression or law of relative motion; and because, while treating attraction as deflective of tangential motion, it overlooks the question, that it may also retard and suppress it, and thus it treats this force as absolute in degree while relative in direction.

An idea or rule that is absolute in its character can tell us nothing about actual things, though it may regulate our mode of thinking about them. In this instance it bids us seek a cause which maintains cosmical motion against the centralizing force of attraction. We must seek it in this cosmos, just as it is, with its countless bodies, all moving in harmony and yet with countless forms and degrees of motion.

It is impossible to find it in a single initial impulse given at the start of the motion; because the force of attraction of each body on the others would everywhere affect the motion thus given, deflecting, retarding, accelerating, reversing and finally absorbing it, without its having any capacity, as a *vis viva*, of recovering itself. The initial impulse once

given, becomes, as a cause, past and ended, and its assumed effect is uniform velocity forever; but it does not assume to resist the retarding, accelerating and other disturbances that assail the body, and it is impossible that it can do so. Nor can it resist the attraction of its central body, which is constant in its direction, and also in its degree so long as the distance is unchanged. A force that interferes to deflect a moving body must thereby decrease its velocity, and the more direct the interference the greater is this decrease, as a direct one may stop it altogether.

In order to get a clear conception of some of these retardations and accelerations, it is necessary to get beyond the motion of each body, in so far as it is merely relative to its primary, and consider it in a more absolute way. Take the moon in its revolution round the earth, starting with it at its first quadrature. Then it is 240,000 miles in the rear of the earth. It must of course overtake the earth, as it does at full moon, and pass on to its second quadrature, where it will be 240,000 miles in advance of the earth; and then, in another half lunation, it must fall back, relatively, twice 240,000 miles to the same relative position from which we started with it.

And it is well to notice that this motion, apparently a circle round the earth, is really, in relation to the sun and in a long period, a series of alternate small undulations on each side of the earth's orbit, the longer ones being on the outside and the shorter ones on the inside, and the difference between their chords being nearly a million of miles; and while the moon is making this slow motion in relation to the earth, it advances near fifty millions of miles with the earth along its orbit round the sun. No other satellite moves so slowly, because no other is so little held by the attraction of its primary compared with that of the sun, which is 2.2 of the earth's, while, in relation to most other satellites, it is measured by thousandths, and in relation to only the two outer satellites of Saturn and Uranus does it rise above hundredths.

Take also the earth in its revolution round the sun. Its apparently circular orbit changes entirely when we take into account the sun's motion in its own orbit, said to be 150 millions of miles a year. If we start with the earth at its vernal equinox, it is 95 millions of miles in the rear of the sun, and in six months it moves forward to a position as far in advance, with the chord of its curve elongated 75 millions of miles by its motion with the sun. Passing its autumnal equinox to the inside of the sun's orbit, it sweeps back in another six months to its original relative position in the rear of the sun, and yet, having moved with the sun, it is found 150 millions of miles in advance of the position whence we started with it, and 115 millions in the rear of its position six months before, and its real annual orbit turns out to be an immense scollop, the loop of which on the sun's orbit is 115 millions of miles wide, the motion being really retrogressive during the second half of each year, and the length of its real journey in absolute space along its real orbit being near twice as great in the first half of the year as in the second half.

Thus all the planets and satellites have orbits consisting of very long

curves in the outer half of each revolution, connected together by short curves, some of them loops, in the inner half, and perform journeys immensely greater in absolute space in one than in the other. Surely it is impossible that these alternations of fast and slow motion can be accounted for by the single transient impulse given to each body at the start of the system. Surely we are required to find some constant abiding or constantly renewed force to account for such phenomena. What is it?

Where shall we find the force that prevents the consolidation and centralization threatened by the force of attraction? Of course we must find the answer in the phenomena of our solar system, that being the only one of which observation gives us any competent knowledge. Philosophy cannot go back to find it in the phenomena of creation, for that is not phenomenon for us, and therefore that process must ever remain transcendental to us, until we can witness it in some other system and transfer it by analogy to our own; the only way in which we can know anything of our own personal origin.

All these regulated and phenomenally self-sustaining movements have a strong analogy to life, though we do not conceive of life as a mere property or movement of matter in a system. Phenomenally and statically it is the normal interaction of all the particles of a given system that sustains and constitutes its life; though this definition cannot deter us from our natural seeking after the dynamics of the system, the forces and causes of this interaction. And so it is in our investigation of the solar system.

We have given to us, by observation of it, over one hundred cosmical bodies, each revolving about some other, which is also moving, and each having a force attractive of all others, and moving at such a distance and with such velocity that it is neither drawn to nor driven from its central body. We find therefore a permanent system of moving and attracting bodies, and for convenience in the study of this fact, we analyse it into two forces—bodies attracting and bodies moving, or, more simply into attraction and motion; though in physics and apart from bodies, these last are nothing but abstract ideas, being the mental instruments by which we handle the actual and concrete forces—bodies moving and attracting.

We infer that the forces of attraction and of motion balance each other so as to prevent both consolidation and dissolution; but neither, by itself, can maintain the system. Without seeking after the origin of these motions, it is enough for us, that, at any given instant of time, they balanced the force of attraction. Then the question arises—how is this system of motions maintained? Or more definitely thus—given a satellite revolving round a planet, itself round another body and it round another, how is the motion of the satellite maintained? What is there in the forms and forces of this system that constantly restores the proper degree of motion in the satellite amidst the retardations and accelerations which we have discovered?

The readiest illustration of the system is the motion produced when a

ball at the end of a string is swung from right to left around one's hand as one moves rapidly in the same direction around a path, composed of a series of curves or loops all turning to a common centre. If we analyze the motion of the ball, we find that, while, relatively to the hand, it is nearly circular, it really performs a very complex figure relatively to the centre of the greater circle in which the person moves, passing an equal or nearly equal portion of time on each side, and yet with a much shorter path and slower motion on the inner, than on the outer side; this difference being always increased with the rapidity of the motion in the larger circle and with the slowness of that in the smaller one. Thus the ball's motion may resemble that of the most remote planets or of our moon, consisting of a series of alternate long and short undulations, or that of the other planets and satellites, being a series of scollops or of alternate long and short curves looping into each other.

And while the ball is performing this motion, the hand does not keep on the line of the greater circle, but performs a series of motions alternately on each side of it, corresponding in form to the larger ones of the ball; and in this its motion resembles the small motion of the planet on its orbit, no planet having a satellite ever moving exactly along its theoretic orbit.

Let the moving ball represent the tangential, and the string the attractive force of the whole movement, and we have the statical condition of a balance of forces. But the tangential force, not being a *vis viva*, would soon give way to the other, if there were no recuperative arrangement in relation to it, and our illustration directs us to the actual arrangement. It consists of the constant motion of the central force. This is the key to the dynamics of the system: attraction by a constantly and peculiarly moving central body. Of course both bodies exert this force, though that of the central body is always immensely greater than that of the other: it is all one force acting along the same line.

This is the moving force that maintains the motions of its dependent bodies, and we find no repulsive force; though, for distinctness of thinking, we find it necessary to analyze the motion into radial and tangential elements, and consider these as representing two colliding forces. A system of forces is an essential element of every system of actual things, and there can be no motion within the system except what is given or upheld by the very forces that constitute the system, supposing of course no interference from without.

This is a force constantly acting, and moving as it acts, ever changing the position whence it acts and therefore the direction of its action; always departing from its point of action and therefore from the very results which its action in each moment tends to produce; always fluent in itself and always fluent in its effects.

As the planet sweeps, with its unsteady rythm of undulations, along its own series of scollops or loops, called its orbit, the satellite sweeps tangentially throughout that orbit; and thence, obeying the attractive force of the planet without giving up the force of its own motion,

bends its course into a curve which carries it out far beyond the planet's orbit, and, still further obeying the same force, it hastens forward with it until, passing in advance of it, its speed is checked by the same force, and it swings round through the same orbit and is, by the force of its own motion, carried far inside of it, where it reduces its speed, because, by reason of the forward motion of the planet, this motion can there make but little draft upon it, and waits until the planet again passes in advance of it and renews its force, when it rises again through the orbit, and repeats the same series of movements. Here then is the force that corrects all the irregularities of motion in the system, checks all accelerations and revives from all retardations. By analogy to the term central force, I venture to call it the orbital force of cosmical motion, because it proceeds from a body moving in its orbit. I think I have said enough to present the subject sufficiently to those who desire to think about it.

But it is impossible to stay the mind at this point; it must seek to find the next link backwards in the chain of causes. If thus planets move and maintain the motions of their satellites, then the sun must move in a similar way to maintain the motions of the planets; and we have evidence that it is so. And the sun also must have its moving centre, and so on indefinitely. This too we may suppose, though we have no direct evidence of it.

This ought not to surprise us; for no where, in the acquisition of knowledge, does observation carry us back to the Great Centre of all causes, nor often to very remote ones; and yet it is a natural process of our philosophic faith to reach out and assume a cause for every thing, and we do assume it in harmony with the character of the effect; physical or spiritual, moral or intellectual, personal or impersonal, according to its demands. Thus only can we fill up the inevitable gaps which experience and observation leave to be supplied in every investigation; and thus we are continually led back to the assumption of causes, principles and ideas that can be, as it were, felt by the mind, and which yet transcend all the definitions and manipulations of deductive logic. All our abstractions are natural reachings of the mind towards the absolute in some special aspect of it, and often we make thereby very valuable acquisitions.

And certainly it is not desirable that we should have capacity to start from first causes and deduce from them all the systems and events of the universe; for our happiness depends, not upon the reach of our minds, but upon their continued and proper growth; and this can be only a gradual process, rising from the observation of things and events and from a study of their dynamics to proximate causes, and from a co-ordination of these to more remote and higher ones, without any supposable end to the means or to the functions of our progress. A mind whose chief function is growth cannot commence with the condition to which it aspires, for then it could have neither growth nor aspiration.

And it is not chargeable as a vice, that we are compelled to postulate

forces beyond the special system which we are studying, analogous to those found in it, nor even if we postulate others within it. Every system of actual things requires such postulates to connect it intellectually with some higher system, or to furnish it with at least a provisional foundation, or to give completeness to its structure; and especially every phenominally self-sustaining system requires us to postulate and then seek within itself the forces by which it is maintained, besides its initial force proceeding from without. Thus every class of plants and animals has within itself the forces by which the creative act is maintained, though always dependent on the larger system of the universe; and the science of physiology is founded on this assumption.

In the study of language, having no history of its origin, we may assume that it was a gift by God to man; but, thus received, it could be but very feebly maintained as a mere treasure of the memory, and in the very form in which it was bestowed; and, in order to account for its continuance in all its varieties, with its degradations, restorations, additions and improvements, even with a fundamental identity of structure, we must postulate other mental forces, which, with memory, constitute our faculty of language, and then proceed to seek them out.

And so it is with law, government and religion, with all their rules, forms, rites, symbols, and principles of faith and conduct. Their origin may be beyond our reach; but we are not, for this reason, prevented from learning that memory is the mere servant of other faculties in maintaining them through all the changes which they, with man, undergo, and that it is a prominent function of our life to work out our own development of them, and to improve by doing so.

I now venture to suggest very generally and briefly some of the consequences that would seem to follow from the admission of the dynamical views here presented.

1. We must give up Sir Isaac Newton's mode of accounting for the elliptical form of cosmical orbits. I expressed this in August, 1860, to the Academy of Science and Arts at Pittsburgh, founding it merely on the fact that all cosmical centres are themselves moving. The foregoing considerations now make this result more obvious.

2. There are many forms of cosmical motion, treated as inequalities, which are as normal elements of the special or partial system in which they are found as are the eccentrics on the axis of a steam engine, and they are not abnormities or disturbances produced by the forces of bodies out of the system, though they may themselves, in some cases, be disturbed, exaggerated, obliterated or even reversed by such forces. I venture to name as belonging to this class, the moon's annual equation, the motion of apsides, variations of eccentricity and of major axis, and also the recession of planetary nodes, including the procession of the equinoxes

3. This orbital force requires great inequalities of relative as well as of absolute motion, and presents a very obvious explanation of the inequalities of the moon's motion as the earth, with its unequal velocity,

passes from perihelion to aphelion and back. Considering the real form of the moon's orbit in relation to the sun and to the earth and its distances from each, and the very small angles of eight minutes formed at the sun by the radius of its orbit at its quadratures, and of one minute at its syzigies, it does not seem that such inequalities can be mere disturbances of the moon's orbit by the central force of the sun.

4. This force would seem also to require a change in the mode of calculating cosmical disturbances. Instead of starting us from the basis of an ideal ellipse, depending on a transient force of unknown quantity, it gives us real ones depending on a constant force for each case, which may be calculated. The forms thus given must be the true normal forms of the respective orbits, and departures from them must alone be treated as disturbances.

I have only to add that, however unsatisfactory it always is to eliminate any element of a system by declaring it anomalous, yet I do not see how this is to be avoided in relation to the satellites of Uranus, if the observations reported about them are accurate.

Stated Meeting, October 1, 1869.

Present, twenty-two members.

Prof. CRESSON, in the Chair.

A letter accepting membership was received from Linant Bey, dated Cairo, April 20, 1860.

An extract from a letter from M. Carlier to Mr. Durand respecting the Michaux Legacy was read.

An extract of a letter from Mr. Lesquereux to the Secretary respecting Mr. Schimper's Palæontologie Végétale was read.

Donations for the Library were received from M. Linant de Bellefonds Bey, the British Association, the London Geological Society, Mr. Gore, F. R. S., and the Boston and Montreal Natural History Societies.

The death of Dr. Dorr, member of this Society, at Germantown, Sept. 18, aged 73 years, was announced by Mr. Fraley.

Prof. Mayer laid before the Society an abstract of the photographic observations of the total eclipse of the 7th of August at Burlington, Iowa, with numerous photographic plates and illustrations.

Prof. McClune exhibited a drawing of the appearance of the Sun to the naked eye made by Prof. Gummere and himself, and described some of the phenomena of the eclipse.

Prof. Morton exhibited a copy of the photograph picture got by Mr. Whipple in 40 seconds, for Prof. Pierce's party of observation; the object being to obtain by a longer exposure than usual with sun pictures, an image of the corona. Photographs of the protuberances required but 5 to 16 seconds; those of the sun before total immersion were exposed but the one 500th of a second, a narrow slit in a flying trap-cover serving to sweep a beam of light across the plate.

Mr. Chase gave the results of his further discussion of Mr. Dines' weather records in England.

Pending nominations 627–642 were read.

And the Society was adjourned.

TIDAL RAINFALL BY P. E. CHASE.

Since the publication of my paper on the Tidal Rainfall of Philadelphia, (Proc. A. P. S. v. x, pp. 523–537), Mr. Dines has continued his discussion of "the moon's influence upon the fall of rain" (Proc. Meteorolog. Soc. for April 21, 1869), adding forty years' observations at Chiswick to those at Cobham, which he had previously examined.

The evidences which I have adduced of "establishments" in the tidal rainfall, and of more strongly marked characteristics in low latitudes, forbid any general inferences from observations at two stations which are so near each other, and in so high a latitude as Cobham and Chiswick. But my study of laws that have been developed by records at more than a hundred different observatories, in Europe, Asia and America, led me to look for additional confirmation of those laws even in the valuable abstracts which rendered Mr. Dines so skeptical. I accordingly "smoothed" the irregularities, both in the Cobham and in the Chiswick tables, and arranged and treated in a similar manner President Caswell's observations at Providence, R. I., from December 1831, to May 1860, and the Toronto observations from March 1840, to January 1849. The results are given in the following Tables.

LUNAR DAILY RAIN AT PROVIDENCE, COBHAM, CHISWICK AND TORONTO.

Lunar Dys.	Fall at Providence. Dec. 1, 1831 to Nov. 30, 1841	Dec. 1, 1841 to Mar. 31, 1851	Apl. 1, 1851 to May 31, 1860	Providence Normals. 1831—41	1841—50	1851—60	1831—60	Lunar Dys.	Cobham Normals	Chisw'ck Normals	Toronto Fall	Toron'o Normals
1	7.58	13.34	20.45	649	871	1051	2572	1	2096.59	2123.32	5.75	532
2	12.07	12.78	15.42	720	819	946	2485	2	2064.42	2146.70	13.10	627
3	13.10	13.43	9.10	798	785	843	2425	3	2072.13	2148.28	10.65	624
4	13.98	8.73	12.51	828	796	811	2434	4	2102.64	2139.65	7.92	571
5	13.22	13.53	15.95	818	862	818	2498	5	2112.27	2105.04	6.47	552
6	9.92	19.33	9.80	847	905	821	2572	6	2066.98	2032.78	9.80	606
7	13.64	10.83	13.19	932	882	834	2648	7	2010.92	1967.77	11.16	682
8	23.02	11.94	15.00	961	854	843	2657	8	2024.04	1985.24	12.66	710
9	10.13	15.75	13.43	864	850	804	2518	9	2095.94	2082.71	11.23	667
10	10.54	12.04	9.63	748	817	739	2304	10	2142.59	2155.38	7.91	593
11	8.14	14.26	10.85	728	727	701	2156	11	2139.12	2145.07	8.18	554
12	17.15	5.57	11.72	772	633	707	2112	12	2117.62	2100.55	7.70	578
13	8.67	10.31	8.77	810	592	754	2155	13	2079.44	2054.24	10.82	636
14	14.43	9.42	15.53	817	600	812	2229	14	2033.18	2009.76	11.37	668
15	16.41	8.93	14.01	762	639	836	2237	15	2026.34	1995.83	11.66	630
16	5.36	10.14	10.74	689	706	827	2222	16	2050.26	1993.59	7.97	554
17	8.51	14.53	14.26	712	777	814	2304	17	2039.80	1949.40	4.97	516
18	16.25	12.09	12.30	824	835	802	2460	18	1998.82	1900.17	10.23	547
19	15.15	11.90	12.19	896	804	807	2507	19	2002.99	1941.88	8.70	615
20	13.98	18.96	10.57	889	942	868	2698	20	2077.74	2085.00	10.66	667
21	11.20	12.96	17.37	870	935	956	2761	21	2146.76	2213.61	14.02	666
22	15.89	15.08	19.31	871	876	990	2737	22	2118.39	2200.21	6.17	631
23	12.75	11.89	9.27	862	801	975	2639	23	2016.49	2059.24	10.01	622
24	14.03	10.67	19.17	826	746	971	2538	24	1962.35	1932.40	10.34	642
25	10.69	11.83	13.57	783	713	970	2466	25	2002.72	1904.18	12.16	652
26	12.96	9 59	16.55	763	747	941	2451	26	2065.88	1921.18	6.23	644
27	9.25	11.12	12.62	763	862	920	2550	27	2103.81	1922.79	14.62	612
28	16.47	19.43	12.03	758	991	958	2706	28	2139.50	1936.00	6.53	548
29	8.77	18.35	20.77	704	1021	1033	2758	29	2167.64	1992.72	5.93	491
30	10.34	12.92	13.81	646	952	1081	2678	30	2148.55	2067.47	8.83	496

The foregoing Normals not only corroborate the inferences in my previous papers, but they also show that the eastward movement of storm waves, which has been so clearly demonstrated by Prof. Henry, prevails to some extent in the Eastern, as well as in the Western Continent. The Toronto observations cover so short a period, that their independent value in determining the form of the lunar monthly raincurve is small, but when compared with the observations at Philadelphia and Providence, they show that a similar lunar influence is felt at each station, modified by the local establishments.

An extensive investigation and comparison of observations may be necessary, to determine whether the direction of storm-progression in England is determined, either wholly or in part, by the trend of the Doffrafield Mts., or is owing mainly to the earth's rotation. In consequence of Alpine influences I should look for indications in Central Europe, of a subordinate system of storm-waves, moving nearly in the line of the meridian, or at right angles with the general system of the globe.

AN ABSTRACT OF SOME OF THE RESULTS OF MEASUREMENTS AND EXAMINATIONS OF THE PHOTOGRAPHS OF THE TOTAL SOLAR ECLIPSE OF AUGUST 7, 1869.

By Alfred Mayer, Ph. D.

Professor of Physics and Astronomy in the Lehigh University, Penna.

I have the honor to lay before the American Philosophical Society a few results of my measurements and examinations of the Photographs of the Total Solar Eclipse of Aug. 7, 1869, taken at Burlington, Iowa.

The Photographic expedition, of which these photographs are part of its results, was organized by Prof. Henry Morton of Philadelphia, under the authority of Prof. J. H. C. Coffin, U. S. N., Superintendent of the American Nautical Almanac.

The expedition occupied three stations in Iowa; viz. Burlington, Mt. Pleasant and Ottumwa, respectively under the charge of Professors Mayer, Morton and Himes.

Burlington is situate in Lat. N. 40° 48′ 21.″58; Long. 0h. 56m. 13.88s. W. of Washington. It was 7 miles N. of the centre of the moon's shadow.

The telescope used was by Merz & Mahler of Munich, and is the property of the Central High School of Philadelphia. It is equatorially mounted; of 6.42 inches aperture and of 9 feet focus, and is driven by one of Fraunhofer's friction governor clocks.

The sun's image was formed on the plate of the camera by a Huyghenian eye-piece, the lenses of which were specially computed to give the least aberration when they formed an image of the sun in the camera of 2.04 inches diameter. The image of a reticule of two spider threads at right angles to each other was also projected on the plate with the sun's image, and these threads were by me accurately adjusted, the one parallel, the other at right angles to the celestial equator; thus, the photographs have given precise position-angles of the contacts and of the protuberances.

A plate having a transverse slot of $\frac{1}{40}$th of an inch in breadth shot across the eye-piece by the action of a spring and thus gave the exposure during partial phase. The duration of this *flash* of the sun upon the camera has, since the eclipse, been made by me the object of an experimental determination, and by means of an electrical break-circuit clock and chronograph, I have found that the exposure of the collodion plate to the sun's image was almost exactly the $\frac{1}{500}$th of a second.

[Prof. Mayer here exhibited the camera used; explained the action of the exposing plate and how by its fall the time of exposure was electrically recorded on a chronograph fillet; and showed the arrangement of the aparatus by which he determined the time of exposure.]

While taking the photographs during partial-phase only 2 inches aperture of object-glass was used; but, during totality the full aperture was employed and the slide-plate allowed the whole beam to fall upon the plate. The exposure of the totality photographs varied from 5s. to 7s.

Forty-one perfect photographs were taken during the eclipse, and five of these were obtained during totality, which lasted 2m. 42s. The five totality pictures were taken in one minute and thirty-nine seconds.

[Prof. Mayer here exhibited copies on plate-glass, taken from the original negatives with an orthoscopic lens, and also copies on paper enlarged to about five inches in diameter. A large diagram showed more distinctly to the members the forms and positions of the protuberances.]

Photograph No. 4, taken 2.8 seconds after *observed* contact, shows a depression in the sun's limb at the position of first contact, and from this depression shoots into the sun a high lunar mountain, whose position measured from the S. point of the cusp, is about $\frac{1}{4}$th of the distance to the N. point of the same. Mr. W. S. Gilman, Jr., of New York, who observed with exquisite skill at Sioux City, Iowa, informed me that he obtained his time of first contact by seeing this mountain peak thrust itself into the sun's limb before a flattening occurred from the contact of the lower general surface of the moon.

[Prof. M. here gave an account of the geometrical methods used to determine the times and angles of contact from measurements on the cusps of the sun.]

The time of first contact deduced from approximate measures on two plates gave 13h. 2m. 1.24s., Burlington Sidereal Time, which is 1.1s. before contact as observed by Prof. Coffin, and 0.1s. before Dr. Gould's observation. From measures on another plate we deduced 13h. 1m. 57.3s., which is 4s. before contact as observed by Dr. Gould, and $\frac{6}{10}$th of a second after contact as determined by Prof. Young with his new spectroscopic method of observation.

Measures on plate No. 8 gave for the position-angle of first contact	—70°	48′
Computed angle	—71°	
Difference	—0°	12′
Plate 41 gave for position-angle fourth contact	108°	34′
Computed angle	108°	0′
Difference	+0°	34′

Sixteen spots were visible on the sun's disc during the eclipse. Two large spots, one in the S. W. quadrant, the other in the N. E., are beautifully defined on the photographs. Near the eastern point of the sun's limb is a remarkably beautiful and characteristic spot, greatly fore-shortened from its position so that the penumbra has disappeared on the west side of the umbra, against which rests the large bright faculae, which enclose the spot, while one bridges over the spot in a N. E. direction and seems to divide it into two portions. I here exhibit drawings of the spot in the S. W. quadrant which show the rapid changes which took place in the form and dimensions of this spot in 1h. 59.5m., the interval between the times of taking the plates from which they are drawn.

On plate 4, we see the umbra and penumbra of a general circular outline, with an intensely white projection into the N. W. point of the margin of the penumbra. The mean diameter of the umbra is 6,630 miles.

Plate 42 shows that the circular outlines of umbra and penumbra have changed into elliptical boundaries, the direction of the longer axis being N. W. and S. E. The umbra has widened in this direction 4″, or 1796 miles, and has, in the transverse direction, narrowed its breadth 5.″5, or 2357 miles, while the outward projections of the umbra (which can be identified on plate 4) have become greatly lengthened.

Photograph No. 15, of the series, shows this spot *bisected* by the limb of the moon.

All the photographs show a gradation of shade from the border of the sun inwards. This shading of the source of light is due to the absorption of the peripheral rays which necessarily pass through a greater thickness of the dense solar atmosphere, than those which emanate from the central portion of the disc.

We also observe on the photographs close to the limb of the moon, a bright glow like that of early dawn, which on plate No. 11 can be distinctly traced to 18″ beyond the limb of the moon. If this phenomenon cannot be explained in mode and in *measure* by diffraction, it must be due to a lunar atmosphere, though it is difficult to reconcile its existence with the inappreciable refractive effect on small stars, and especially on double stars, when occulted by the moon.

I will not attempt at present a complete description of the plates obtained during totality. I merely refer you to the diagram which I have prepared, and call your attention to those of the most remarkable protuberances. These protuberances I have numbered from 1 to 12, going from N. through E. to N.

No. 4, on the eastern limb of the sun, has the appearance of an eagle with outspread wings resting on the trunk of a tree which leans towards the north, on plate No. 27, where the base of the protuberance is cut off by the advancing moon, the resemblance to an eagle on the wing is perfect. The form of this object indicates instability, and impresses one with the idea that it is a great travelling whirl of flame, the direction of whose rotation—as indicated by the position of "the wings" and the projection of one on the other—is retrogade or in the same direction as the hands of a watch. I have examined with care the successive photographs of it, and although at first I thought the last impression differed from those preceding in that the wings had become longer and more in a line with each other, yet, on subsequent examination, I could not really decide that a perceptible motion had taken place during the time of totality.

The position-angle of the N. side of the base of this object is 96° 25′; its height is 1′ 22″, or 33,700 miles, and the spread of the wings is 9° 31′, or 70,800 miles.

On the western limb of the sun we see the remarkably large and massive protuberance No. 8. It is shaped like an albatross head, with the beak and under-side of the head resting on the periphery of the moon. On a photograph taken at Ottumwa, Iowa, just before the sun came out, this protuberance had the exact appearance of an albatross head, with the beak open, holding a rounded mass between the extremity of the jaws. It lies between the position-angles of 230° 13′ and 245° 46′; its

length is 15° 33′, or 115,700 miles, and its greatest height is 75″, or 33,600 miles.

The protuberance No. 10, bears the most striking resemblance to a caterpillar, out of whose head issue two horns; the one nearest the front being the higher of the two, and terminated with a knob or ball from which comes a broken line of light to the border of the moon. Its mean position is 287° 33′ and it extends through 11 degrees or 81,800 miles. Its maximum elevation, which is at the head of "the caterpillar" is 52″, or 23,300 miles.

We here give a table of the position-angles and heights of the protuberances. Those on the eastern limbs of the sun, viz: 1 to 7 inclusive, were determined from measurements on the first plate of the totality series, taken 17.1 seconds after second contact; those on the western limb of the sun were determined from the last plate of totality, taken 50 seconds before third contact.

The angles of position of prominences, 1 to 7 inclusive, should be *diminished* 32.′5, to make them correspond to the positions they had on the first plate of totality; for reasons which are given in my official report.

Table of the position-angles and heights of the Prominences.

No. Prominence.	Position-angles.	Height.	
1	55° 9′ to 57° 59′	22″	
2	66° 14′ to 72° 21′	22″	
3	87° 15′	75″	
4 (base of)	96° 25′ to 98° 4′	82″	
4 (tip of N. wing)	90° 39′		
4 (tip of S. wing)	100° 10′		
5	101° 23′ to 118° 36′	136″	(nebulous cloud.)
6	146° 25′ to 149° 30′	45″	
7	156° 46′ to 161° 59′	37″	
8	230° 13′ to 245° 46′	75″	
9	273° 27′		
10	282° 13′ to 293° 12′	52″	
11	315° 54′ to 321° 12′	44″	
12	342° 7′ to 343° 58′	15″	

Observations on the application of photography to the determination of the times of contacts during the transit of Venus in 1874 *and* 1882.

We here venture a few remarks, showing the peculiar value of photography in the observations of the transits of Venus.

It has been shown that the sun's image was photographed on the camera plate with an exposure of only $\frac{1}{500}$th of a second; and the duration of exposure for any other instrument can be determined with as great precision by the method which I employed.

The instant the mechanical movement exposes the plate, it also records the time of that exposure on a chronograph connected with a break-circuit clock, and thus we have an accurately delineated *figure* of the transit

corresponding to a *time* marked on the face of the clock employed; and this correspondence of figure and time is unaffected with personal equation either of sight or of hearing. Now if the error and rate of the clock can be entirely freed from the personal equation of the observer who determined them, and if the longitude of the station be found by the coincidences of the beats of a sidereal clock with those of a break-circuit mean solar clock placed at the observatory of the first meridian, we have the most accurate means of obtaining the *absolute* times of contacts at the station of observation.

Thus we see how applicable will be photography to these observations, for the data of the solar parallax will be given either by observing *the absolute time* of the ingress or of the egress (which method is alone of value in the transit of 1874), or by determining *the duration* of the transit of Venus over the solar disc. The photographs are *permanent* phenomena on which we can repeat our measures at leisure, with every appliance of precision, while it is impossible to attain a similar degree with eye and ear, from the difficulty of micrometically measuring at a *precise* instant the distance of Venus from the sun's limb, and from the (recorded) distortions of Venus at contacts.

It will also be of great value to have a photographic record of the appearance of Venus at the contacts, for, *if* the disc of the planet then should appear on the plate to depart from a circle and have attachments to the sun's limb, these distortions can be measured and allowed for.

An idea may be formed of the apparent size of Venus during its transit of the sun's disc, from the fact that the umbra of the solar spot in the south-west quadrant is $15''$ in diameter, and that Venus at transit will subtend an angle of about $70''$; so that the planet would appear on the plate as a disc $4\frac{2}{3}$ times the diameter of this spot, or, as a disc of .107 inch diameter on an image of the sun of 3 inches in diameter.

The negatives of these photographs I find from trial will stand a magnifying power of 50 under the micrometer, and as $1''$ of arc will equal $\frac{1}{700}$th inch on a solar image of 3 inches diameter, we can, with the above mentioned power, divide a second into ten parts. This supposes, however, that the bisection by the micrometer thread is on a perfectly well defined point, and this does not exist in the outlines of any photograph, and especially is the limb of the sun indistinct on account of its shading, and of the manner in which the silver is deposited in the collodion film.

From actual experience in measurements under the micrometer, I find that we cannot, as yet, hope to make a bisection on the sun's limb closer than $\frac{1}{2}$ of a second. On the boundary of the umbra of a well defined solar spot, we can read to $\frac{1}{4}$ of a second, and from this I should think the $\frac{2}{10}$ of a second might probably be attained as the limit in a reading on the limb of the image of Venus.

But with measures as close as these, and the tables of Venus brought to the accuracy which existing unreduced observations can give, we may reasonably hope for a determination of the solar parallax comporting with the most exact astronomical measures of this century.

The Lehigh University, Pa., 7th September, 1869.

Stated Meeting, Oct. 15, 1869.

Present, eleven members.

Prof. CRESSON in the Chair.

A letter from Prof. Newton of Yale College, to the Secretary, in behalf of M. St. Claire Deville, Director of the New Observatory at Paris, requesting exchanges, and announcing the transmission of the Bulletin of the Observatory, was read, and, on motion, the Observatory was ordered to be placed on the list of correspondents to receive the Proceedings.

Letters acknowledging the receipt of Transactions, Vol. XIII., Part 3, and Proceedings No. 81 were received from the Peabody Institute at Baltimore, and the New York Lyceum of Natural History.

Donations for the Library were received from Prof. Zantedeschi, the Essex Institute, the Boston S. N. H., the American Academy of Arts and Sciences, Mr. E. M. Stone, of Providence, the New York Lyceum, the Philadelphia Academy of Natural Sciences and Medical Journal, and the State Department and Coast Survey Bureau at Washington.

The Committee to which was referred the Memoir of Dr. Brinton, entitled the "Arowack Language of Guiana," &c., reported in favor of its publication in the Transactions; and on motion of Mr. Fraley it was so ordered.

Prof. Cresson laid before the Society a profile of the elevations attained by the recent flood in the Schuylkill river, for a distance of 34,200 feet above the dam at Fairmount, and from the dam to Chestnut street Bridge, with a table of

heights reached by the floods of previous years. He ascribed the extra elevations, at certain points along the profile section, to the obstruction which a narrowing of the water basin, or a change in its direction, should produce. Instead of the usual difference of 1.8 foot, between the levels of the surface of the water, at the head and at the foot of Fairmount pool, there occurred a difference of 20 feet, at the height of the flood. Oscillations in the flood-level, averaging six minutes in duration, were observed on the shores, and in the forebay, near the dam, the greatest of which was about 18 inches in vertical extent. The maximum velocity of the water was about nine miles an hour where it passed over the dam.

Height of Water above.		*Water Works Guage.*	*City Datum.*
1822 Ice flood of	Feb. 21.....	9.08	..... 13.17 feet.
1839	Jan. 26.....	10.17	..... 14.25
1840	Feb. 10.....	7. 0	..... 11.09
1841	Jan. 7.....	8. 0	..... 12.09
1846	March4.....	7. 1	..... 11.17
1850 Summer	July 19.....	8. 0	..... 12.09
1850 Autumn	Sep. 2.....	10.92	..... 15.01
1857	.....	7. 0	..... 11.09
1869	Oct. 4.....	11.64	..... 15.73

Nominations for membership were read and balloted for.

On motion, the New Bedford Public Library was ordered to be placed on the list of correspondents to receive the Proceedings from the beginning.

The ballot-boxes were then examined by the presiding officer, and the following persons declared duly elected members of the Society:

Miss Maria Mitchell, of Vassar College, N. Y.
Mrs. Mary Somerville, of England, now of Naples.
Mrs. Elizabeth Agassiz, of Cambridge, Mass.
Charles Darwin, of England.
George Rawlinson, of England.
Louis Gruner, Ecole des Mines, Paris.
Carl Vogt, of Geneva.
Carl T. E. Von Siebold, of Munich.
Carl Fr. Naumann, of Leipsig.

Ferdinand Von Hochstetter, of Vienna.
George Von Frauenfeld, of Vienna.
Philip T. Tyson, of Baltimore.
Edward Hopper, of Philadelphia.
Charles Bullock, of Philadelphia.
Alfred M. Mayer, of South Bethlehem, Pa.
George W. Anderson, of West Haverford, Pa.

And the Society was adjourned.

Stated Meeting, Nov. 5, 1869.

Present, fifteen members.

Mr. Fraley, Vice-President, in the Chair.

Mr. Edward Hopper was introduced to the presiding officer and took his seat.

Letters accepting membership were received from Miss Maria Mitchell, dated Vassar College, Pokeepsie, Oct. 22d, Mrs. Agassiz, dated Cambridge, Nov. 1, and Prof. Alfred M. Mayer, dated Lehigh University, S. Bethlehem, Oct. 26, 1869.

Letters of Envoi were received from the Academies at Vienna, Göttingen, Stockholm, the Royal Society, and the Manchester Literary and Philosophical Society.

Donations for the Library were received from the Acade

mies at Stockholm, St. Petersburg, Copenhagen, and Philadelphia; the Societies at Riga, Moscow, Bamberg, Frankfort am Main, Manchester, Quebec, and Montreal; the Geographical and Geological Societies of Vienna, the Observatory at Göttingen, Prof. Rütimeyer at Basil, the Observatory of Montsauris, the Anthropological Society and School of Mines, at Paris, the Royal Society, and Meteorological Committee, R. Geographical, Zoological and Asiatic Societies at London, the R. Geological Society at Dublin, the Franklin Institute, Prof. Kirkwood, and the Cornell Library at Ithaca, N. Y.

A Communication for Publication in the Proceedings of the Society was received from Dr. Hayden, entitled Field Notes on the Geology of Colorado and New Mexico, by F. V. Hayden, U. S. Geologist.

On motion, permission was granted to Mr. George Harding to have a photographic copy made of the Society's engraved likeness of Chief Justice Marshall.

Mr. Price, as Chairman of the Michaux Legacy Committee, reported that the Society was now in possession of the documents sent by M. Carlier, and moved the following resolution, which was adopted;

Resolved, That the thanks of the American Philosophical Society are due and are hereby cordially tendered to M. Auguste Carlier, for his devoted attention to and successful accomplishment of the establishment of the claim of the society for the legacy given by the will of the late André François Michaux for its use, and that the officers of the society be requested to transmit a copy of this resolution to him, in testimony of their grateful appreciation of his disinterested services in the matter of said claim.

A paper entitled Second Addition to the History of the Fishes of the Cretaceous of the United States, by Ed. D. Cope, was presented and its reading postponed. (See page 240.)

And the Society was adjourned.

Stated Meeting, Nov. 19th, 1869.

Present, fourteen members.

Mr. Cresson, Vice-President, in the Chair.

A letter, dated Paris, Oct. 25th, 1869, was read from M. Carlier, informing the Society officially of the termination of his duties as agent for the Society in the matter of the Michaux Legacy.

Circular letters were read, dated Nov. 1, 1869, from Mr. Axel Erdmann, chief of the Geological Survey of Sweden, announcing the transmission of charts and pamphlet descriptions of the Survey, and requesting exchanges.

Donations for the Library were received from the Swedish Survey, the Geographical Society of Paris, the London Astronomical Society, the Boston Society of Natural History, Yale College, Dr. Newberry, the New Jersey Historical Society, the General Superintendent of Freedmen Schools at Washington, and Dr. J. W. Hoyt of Wisconsin.

A communication was read entitled "On Comets and Meteors, by Daniel Kirkwood, LL. D., Professor in Indiana University." (See page 215.)

A communication was read by Judge Lowrie, entitled a search for a "Normal Cause of the Recession of Cosmical Nodes." (See page 220.)

Dr. G. B. Wood exhibited a number of Indian relics, disinterred from a bed of sand in the neighborhood of his residence in Southern New Jersey, consisting of portions of the skull and leg bones of a man, who had been buried in a sitting posture,

with the face towards the East; and a finely wrought celt, or hatchet to be held in the hand, and a flaked spear-head, buried with the corpse. The bones were not fossilized; but their cancellated tissues were filled with fine sand, and their age appeared very considerable when a comparison was instituted with those of the skeleton of a white man, buried in the same neighborhood, about a century ago. There were also obtained, from that neighborhood, rubbed and furrowed hammer-heads, a large and well formed pestle, other implements apparently made out of Delaware pebbles, and a large quern, or mill-stone, of rock brought also from a distance. A ridge, composed chiefly of oyster-shells, near by, is popularly accounted for by supposing it to have been formed of the refuse of the food of the aborigines. Dr. H. C. Wood explained it as an out-crop of a shell-bed of Eocene Tertiary age. This is the more interesting, as the Tertiaries of New Jersey have been supposed to belong exclusively to the Miocene age.

Dr. H. C. Wood communicated to the Society some recent experiments which he had made with Veratria, after which he considered it proved, that purgation was connected especially with the action of the pneumo-gastric nerve-system.

The minutes of the Board of Officers and Members in Council were read.

Dr. Carson described the character of the Memoir upon the Physiological Qualities of American Hemp, and the reasons influencing the Board to recommend it, not for the Magellanic, but for an extra premium, in accordance with the action of the Society, of date Feb. 12, 1864; whereupon, on the motion of Mr. Fraley, it was

Resolved, That an appropriation of one hundred dollars be made from the income of the Magellanic Fund, for the payment of the said premium, and that said sum be transmitted to the author of the essay, with a suitable certificate engrossed on parchment, of the award of said premium, said certificate to be under the Seal of the Society, and to be attested by the signature of the officers thereof.

Resolved: That said essay be published in the proceedings. (P. 226.)

New nominations Nos. 643 to 648 were read.

ON COMETS AND METEORS.

By Daniel Kirkwood, LL. D., Professor in Indiana University.

Read before the American Philosophical Society, Nov. 19, 1869.

The comets which passed their perihelia in August, 1862, and January, 1866, will ever be memorable in the annals of science, as having led to the discovery of the intimate relationship between comets and meteors. These various bodies found revolving about the sun in very eccentric orbits may all be regarded as similar in their nature and origin, differing mainly in the accidents of magnitude and density. The recent researches, moreover, of Hoek, Leverrier and Schiaparelli, have led to the conclusion that such objects exist in great numbers in the interstellar spaces; that in consequence of the sun's progressive motion they are sometimes drawn towards the centre of our system; and that if undisturbed by any of the large planets they again pass off in parabolas or hyperbolas. When, however, as must sometimes be the case, they approach near Jupiter, Saturn, Uranus or Neptune, their orbits may be transformed into ellipses. Such, doubtless, has been the origin of the periodicity of the August and November meteors, as well as of numerous comets.

In the present paper it is proposed to consider the probable consequences of the sun's motion through regions of space in which cosmical matter is widely diffused; to compare these theoretical deductions with the observed phenomena of comets, ærolites and falling stars; and thus, if possible, explain a variety of facts in regard to those bodies, which have hitherto received no satisfactory explanation.

1. As comets now moving in elliptic orbits owe their periodicity to the disturbing action of the major planets, and as this planetary influence is sometimes sufficient, especially in the case of Jupiter and Saturn, to change the *direction* of cometary motion, the great majority of periodic comets should move in the same direction with the planets. Now, of the comets known to be elliptical, 70 per cent. *have direct motion.* In this respect, therefore, theory and observation are in striking harmony.

2. When the relative positions of a comet and the disturbing planet are such as to give the transformed orbit of the former a small perihelion distance, the comet must return to the point at which it received its greatest perturbation; in other words, to the orbit of the planet. The aphelia of the comets of short period ought therefore to be found, for the most part, *in the vicinity of the orbits of the major planets.* The actual distances of these aphelia are as follows:

I. *Comets whose Aphelion Distances are Nearly Equal to* 5.20, *the Radius of Jupiter's Orbit.*

Comets.	*Aph. Dist.*	*Comets.*	*Aph. Dist.*
1. Encke's	4.09	7. 1766 II.	5.47
2. 1819 IV.	4.81	8. 1819 III.	5.55
3. De Vico's	5.02	9. Brorsen's	5.64
4. Pigott's (1743)	5.28	10. D'Arrest's	5.75
5. 1867 II.	5.29	11. Faye's	5.93
6. 1743 I.	5.32	12. Biela's	6.19

II. *Comets whose Aphelion Distances are Nearly Equal to* 9.54, *the Radius of Saturn's Orbit.*

Comets.	*Aph. Dist.*
1. Peters' (1846 VI.)	9.45
2. Tuttle's (1858 I.)	10.42

III. *Comets whose Aphelion Distances are Nearly Equal to* 19.18, *the Radius of Uranus's Orbit.*

Comets.	*Aph. Dist.*
1. 1867 I.	19.28
2. Nov. Meteors.	19.65
3. 1866 I.	19.92

IV. *Comets whose Aphelion Distances are Nearly Equal to* 30.04, *the Radius of Neptune's Orbit.*

Comets.	*Aph. Dist*	*Comets.*	*Aph. Dist.*
1. Westphal's (1852 IV.)	31.97	4 De Vico's (1846 IV.)	34.35
2. Pons' (1812)	33.41	5. Brorsen's (1847 V.)	35.07
3. Olbers' (1815)	34.05	6. Halley's	35.37

The coincidences here pointed out (some of which have been noticed by others,) appear, then, to be necessary consequences of the motion of the solar system through spaces occupied by meteoric nebulæ. Hence the observed facts receive an obvious explanation.

In regard to comets of long period we have only to remark that, for any thing we know to the contrary, there may be causes of perturbation far exterior to the orbit of Neptune.

3. From what we observe in regard to the *larger* bodies of the universe —a clustering tendency being everywhere apparent,—it seems highly improbable that *cometic and meteoric* matter should be uniformly diffused through space. We would expect, on the contrary, to find it collected in cosmical clouds, similar to the visible nebulæ. Now, this, in fact, is precisely what has been observed in regard both to comets and meteors. In

150 years, from 1600 to 1750, 16 comets were visible to the naked eye;* of which 8 appeared in the 25 years from 1664 to 1689. Again, during 60 years, from 1750 to 1810, only 5 comets were visible to the naked eye, while in the next 50 years there were double that number. The probable cause of such variations is sufficiently obvious. As the sun in his progressive motion approaches a cometary group, the latter must, by reason of his attraction, move toward the centre of our system, the nearer members with greater velocity than the more remote. Those of the same cluster would enter the solar domain at periods not very distant from each other; the forms of their orbits depending upon their original relative positions with reference to the sun's course, and also on planetary perturbation. It is evident also that the passage of the solar system through a region of space comparatively destitute of cometic clusters would be indicated by a corresponding paucity of comets. By the examination, moreover, of any complete table of falling stars we shall find a still more marked variation in the frequency of meteoric showers.

Previous to 1833, the periodicity of shooting stars had not been suspected. Hence the showers seen up to that date were observed *accidentally*. Since the great display of that year, however, they have been regularly *looked for*, especially at the November and August epochs. Consequently the numbers recently observed cannot properly be compared with those of former periods. Now, according to the Catalogue of Quetelet, 244 meteoric showers were observed from the Christian era to 1833. These were distributed as follows:

Centuries.	*No. of Showers.*	*Centuries.*	*No. of Showers.*
0 to 100	5	1000 to 1100	22
100 to 200	0	1100 to 1200	12
200 to 300	3	1200 to 1300	3
300 to 400	1	1300 to 1400	4
400 to 500	1	1400 to 1500	4
500 to 600	20	1500 to 1600	7
600 to 700	1	1600 to 1700	7
700 to 800	14	1700 to 1800	24
800 to 900	37	1800 to 1833	48
900 to 1000	31		

A remarkable secular variation in the number of showers is obvious from the foregoing table. During the 5 centuries from 700 to 1200, 116 displays are recorded; while in the 5 succeeding, from 1200 to 1700, the number is only 25. It will also be observed that another period of abundance commenced with the 18th century. A catalogue of meteoric stone-falls indicates also a corresponding increase in the number of ærolites, which cannot be wholly accounted for by the increased number of observers. Now, there are two obvious methods by which these variations may be explained. Either (1) the orbits of the meteoric rings which

*See Humboldt's Cosmos, vol. IV. p. 538. The writer called attention to this variation as long since as 1861.

intersect the earth's path were so changed by perturbation towards the close of the 12th century as to prevent the appulse of the meteoric groups with the earth's atmosphere; or, (2) the nebulous matter is very unequally diffused through the sidereal spaces. That the former has not been the principal cause is rendered extremely probable by the fact that the number of epochs of periodical showers was no greater during the cycle of abundance than in that of paucity. We conclude, therefore, that during the interval from 700 to 1200 the solar system was passing through, or near, a meteoric cloud of very great extent; that from 1200 to 1700 it was traversing a region comparatively destitute of such matter; and that about the commencement of the 18th century it again entered a similar nebula of unknown extent.

The fact that the August meteors, which have been so often subsequently observed, were *first* noticed in 811, renders it probable that the cluster was introduced into the planetary system not long previous to the year 800. It may be also worthy of remark that the elements of the comet of 770 A. D., are not very different from those of the August meteors and the 3d comet of 1862.*

Adopting Struve's estimate of the sun's orbital velocity, we find the diameter of the nebula traversed in 500 years to be 14 times that of Neptune's orbit.

It is remarkable that with the exception of Mars the perihelia of the orbits of all the principal planets fall in the same semi-circle of longitude—a fact which can hardly be regarded as accidental. Now, if the orbits were orginally circular, the motion of the solar system through a nebulous mass not of uniform density would have the obvious effect of compelling the planets to deviate from their primitive orbits and move in ellipses of various eccentricities. It is easy to perceive, moreover, that the original perihelion points of all the orbits would be on that side of the system which had passed through the rarer portion of the nebulous mass. We have thus a possible cause of the eccentricity of the planetary orbits, as well as of the observed distribution of their perihelia.†

4. The particles of a cometic mass, being at unequal distances from the sun, will tend to move at different rates and in somewhat different orbits. This tendency will gradually overcome the feeble attractive force between the particles themselves. The most distant parts will thus become separated from the nucleus, and move in independent orbits. The motion of such meteoric matter will be in the same plane with that of the parent comet; the orbit of the former, however, being generally exterior to that of the latter. The connection recently discovered between comets and meteors, and especially the fact that the period of the

* The interval between the perihelion passage of 770 and that of 1862 is equal to 9 periods of 121.36 years. Oppolzer's determination of the period of 1862 III. is 121.5 years. Hind remarks that the elements of the comet of 770 are "rather uncertain," but says "that the general character of the orbit is decided." It may be worthy of remark that a great meteoric shower, the exact date of which has not been preserved, occurred in 770.

† This suggestion is due to R. A. Proctor, F. R. A. S., the distinguished author of "Saturn and its System."

November group is somewhat greater than that of the comet of 1866, are in striking harmony with the views here presented.

5. Owing to this loss of matter, periodic comets must become less brilliant, other things being equal, at each successive return;—a fact observed in regard to the comets of Halley and Biela.

6. The line of apsides of a large proportion of comets will be approximately coincident with the solar orbit. The point towards which the sun is moving is in longitude about 260°. The quadrants bisected by this point and that directly opposite extend from 215° to 305°, and from 35° to 125°. The number of cometary perihelia found in these quadrants up to July, 1868, (periodic comets being counted but once) was 159, or 62 per cent.; in the other two quadrants, 98, or 38 per cent.

This tendency of the perihelia to crowd together in two opposite regions has been noticed by different writers.

7. Comets whose positions before entering our system were very remote from the solar orbit must have *overtaken* the sun in its progressive motion; hence their perihelia must fall for the most part, in the vicinity of the point towards which the sun is moving; and they must in general have very small perihelion distances. Now, what are the observed facts in regard to the longitudes of the perihelia of the comets which have approached within the least distance of the sun's surface? But three have had a perihelion distance less than 0.01. *All* these, it will be seen by the following table, have their perihelia in close proximity to the point referred to:

I. *Comets whose Perihelion Distances are Less than* 0.01.

Perihelion Passage.	*Per. Dist.*	*Long. of Per.*
1. 1668, Feb. 28*d.* 13*h.*	0.0047	277° 2′
2. 1680, Dec. 17 23	0.0062	262 49
3. 1843, Feb. 27 9	0.0055	278 39

In table II. all but the last have their perihelia in the same quadrant.

II. *Comets whose Perihelion Distances are Greater than* 0.01 *and Less than* 0.05.

Perihelion Passage.	*Per. Dist.*	*Long. of Per.*
1. 1689, Nov. 29*d.* 4*h.*	0.0189	269° 41′
2. 1816, March 1 8	0.0485	267 35
3. 1826, Nov. 18 9	0.0268	315 31
4. 1847, March 30 6	0.0425	276 2
5. 1865, Jan. 14 7	0.0260	141 15

The perihelion of the first comet in table III. is remote from the direction of the sun's motion; that of the second is distant but 14°, and of the third, 21°.

III. *Comets whose Perihelion Distances are Greater than* 0.05 *and Less than* 0.1.

Perihelion Passage.	*Per. Dist.*	*Long. of Per.*
1. 1593, July 18*d.* 13*h.*	0.0891	176° 19′
2. 1780, Sept. 30 22	0.0963	246 35
3. 1821, March 21 12	0.0918	239 29

With greater perihelion distances the tendency of the perihelia to crowd together around the point indicated is less distinctly marked.

8. Few comets of small perihelion distance should have their perihelia in the vicinity of longitude 80°, the point opposite that towards which the sun is moving. Accordingly we find, by examining a table of cometary elements, that with a perihelion distance less than 0.1, there is not a single perihelion between 35° and 125°; between 0.1 and 0.2, but 3; and between 0.2 and 0.3 only 1.

Bloomington, Indiana, *September* 14*th*, 1869.

A SEARCH FOR A NORMAL CAUSE OF THE RECESSION OF COSMICAL NODES.

By Hon. Walter H. Lowrie.

Read before the American Philosophical Society, Nov. 19, 1869.

The analogy between the recession of the nodes of all the planets and satellites of the solar system, including that of the earth, called the precession of the equinoxes, is so complete and manifest that the mind, on the discovery of it, naturally inclines to attribute them all to like causes. These phenomena have not been so treated heretofore, but have been regarded as disturbances produced by various causes, the influence of which I do not feel entitled to question, while I think there is a normal cause which ought to be considered.

It seems to me to be a proposition of axiomatic plainness, that, in any system or sub-system of moving bodies, all its periodic motions ought to be presumed normal, rather than abnormal, that is, the causes of them ought to be first sought in the plan of the system itself; and only when this search fails ought we to suspect them to be disturbances caused by forces which are alien to the system. Thus, all the periodic motions of the planets ought to be presumed to depend on their relation to the sun, until the contrary appears; and all the periodic motions of the satellites ought to be presumed to depend upon their several planets.

Our scientific systems consist only of the elements from which, and of the order by which we construct them, and are, therefore, charged with all the defects of our knowledge and constructive skill. In the early stages of astronomy, many phenomena were treated as exceptional and disturbing, which are now known to be normal pulsations of the *vis viva* of the solar system, because now this force is better comprehended. And the same is true of all growing sciences. All our scientific systems are accustomed to discover that their ideals of nature are often very unreal, and that the perturbations, which they attribute to nature, belong only to themselves. Newly discovered facts or principles must always cause some derangement or re-arrangement of the old furniture of the school that admits them.

Now that we know that the solar system is a part of a much grander system, in which the sun itself revolves, we have a fact which is, in many respects of great astronomical importance, and which did not enter into the inductions of former times; and considering its character, it is not unnatural to suppose that it is an essential element in all the motions of the system. If this be so, then our whole system of astronomical dynamics must, to some extent, open up to admit its influence and to submit to such modifications as it may require.

This fact can no more be without influence on the motions of the planets, than can be the revolution of the planets on their satellites. It necessarily made a great change in our knowledge of the form of planetary orbits, though it may not greatly change our reasoning about them. And yet, what is the parallax of a star worth to us now, unless we know whether the sun's motion (say 150,000,000 miles a year) was taken into account, and whether the base of the parallactic angle was 190,000,000 + 75,000,000 miles, or 190,000,000−75,000,000, or some chord of intermediate length? How, without this, shall we value any ancient observation of the place of a star, or the record of stellar movements supposed to be made in the construction of the pyramids? It may now be thought better to take one, or ten, or more years of the sun's motion in the base of such an angle.

Such changes in scientific theories do not often make any serious changes in the laws which observation had discovered as facts, but rather account for them, and show the common bond that unites them in nature and in reason. When the centre of cosmical motion was transferred from the earth to the sun, the laws of the solar system, as they had been learned before, were not annulled. When light changed its base from EMISSION to UNDULATION, the laws of optics were not seriously affected. A law may be true as an expression of observed phenomena, even when its principle is unknown or mistaken, or when it is erroneously supposed to be itself a final and independent principle.

I think the normal cause, not to speak of disturbing ones, of the recession of the nodes can be found in the system or sub-system to which the motion belongs, and that it is the same everywhere. It seems to me to be a necessary consequence of the inclination of the dependent to the

principal orbit, and, so far as we know, this form pervades the whole solar system.

True, we know not yet the direction of the real orbit of the sun, and, therefore, cannot tell how the other orbits are inclined to it. But we know that all the others have different inclinations, and that, therefore, not more than one, and probably none, of them coincides with the sun's. And if the observations of Sir William Herschel and his successors, on the course of the sun, are near the truth, then it is proved that all are so inclined; and we do not mark recessions on the sun's orbit because we have not yet found where it is. Finding the law that recession of nodes always accompanies their existence, we naturally expect a like cause for all cases, a cause growing out of like relations to the main force of the system or sub-system; and therefore we ought to study how the central force operates on a dependent body moving in that form.

Let us be sure, even at the risk at an unnecessary presentation of rudiments, that we have a right possession of this phenomenon of the recession of the nodes, and that it is a phenomenon of the earth's motion. It is, of course, difficult for a person unused to the study of the motions of the solar system to form or retain very clear conceptions of all their changing complications. He will often be mistaken in his geometry of the heavens, and may seldom have the pleasure of more than a transient confidence in his conceptions about it. Occupying a revolving and rotating position, and obliged to find from it the courses and velocities of the shifting currents of the cosmical ocean, and fix them by the floating landmarks of the skies, he will often get confused and suspect himself incompetent.

We shall not need to go beyond the instances of the earth and moon to get illustrations of this motion sufficient to show its unity of form and unity of relation to the central body. It is involved in the geometrical conception of a cosmical system, that, where its orbital planes differ in inclination, each must internode with all the others by a line passing through their common centre, and this is the line of its nodes. But if the planes always maintained the same direction in space, there could be no motion of nodes, and these cross-roads of the skies would be less important and interesting than they now are.

It is admitted that the axes of rotation of all the planets and satellites, except the earth, are fixed and stable, so that they change direction only *with* their orbital planes and not *in* them, and it is supposed that the earth alone tilts *in* its plane. It is admitted also that all these planes except the earth's have a constant warping or tilting motion westward, and that their bodies tilt *with* them, and this causes these planes to cut through any fixed plane further westward in each revolution, and the lines of their nodes to recede on any such plane, and the ecliptic is taken as such a one; but it is supposed that a similar appearance is produced, relative to the earth, by a tilting of the earth itself *in* its plane, marked by its equator on the ecliptic, and not by a tilting *of* its plane. If this be so, then

the earth has the same tilt *in* the moon's plane also, and this would be a further anomaly.

Possibly these differences of statement may be accounted for from the fact, that, besides our ignorance of the sun's motion, the recession of nodes can have value for us only as the nodes are stations on the earth's orbital plane, and can be noted as crossings of this great highway; and, of course, the ecliptic can be no measure of its own inclination, or revolutions, or recession. Certainly the ecliptic does appear to have a tilting motion, completing a revolution in 25,868 years, so that the sun, in that time, will appear to pass over all the stars that are between the tropical circles. And why should we treat this as only an apparent motion of the earth's orbital plane, while admitting that it is real in all other cases?

It may help us here if we take notice of a class of cases wherein there is a real tilting of the axis of rotation of a body *in* its orbital plane. They are all cases where a body moves in two planes at once; as a planet with a satellite, having an inclined orbit, where there is a conflict of two forces, represented by the two planes, and an accommodation between them. Here we assume that the earth, without the moon, would have no tilt or change of direction of its axis *in* its own plane. But it is also in the moon's plane, and this has a tilting revolution round the earth in 19 years. Then this relation of the earth and moon is analogous to their connection by a lever, representing their mutual attraction in the line of the moon's nodes, the fulcrum being their common centre of gravity. If the earth's axis had a fixed position on this lever, it would go with it, and thus have a real tilt *in* its own plane equal to double the inclination of the moon's plane. But it is held by the greater force represented by its own plane and its centre, so that this tilt is very small, called its nutation, having a period of nineteen years, and being only another aspect of the revolution of the moon's nodes. It would perform an ellipse round the ideal pole of the heavens; but, by its combination with the greater motion of the earth's pole by the recession of *its* nodes, it becomes a series of 19-year scollops in that ellipse. Here is a case and a cause of tilting *in* a plane, which no doubt exists in all planets which have satellites, and even in the sun itself, and I think that no other such a case is known to astronomy.

We know of no cosmical cause for this fixedness of axes of rotation; but, without it, we could have no science of astronomy, no measure of time, no measure of direction or position beyond the earth itself; for upon this depends, directly or indirectly, all our astronomical measures. If the earth's orbital plane tilts and revolves, and thus changes the direction of the earth's axis, it is with so slow a movement as not to embarrass the observations and calculations of a human lifetime, and scarcely those of human history, but only to mark those immense periods by which eternity is terraced off before and behind us. If this plane does thus revolve, and if its axis is inclined to the axis of the earth, no matter what may be the dip of its tilt, the poles of the two axes will revolve around each other, and always maintain to each other the same angle of incli-

nation, unless there be some cause that affects the fixedness of one of them.

We are to seek the cause of recession of nodes in a system so constructed and so operating, by the force of cosmical attraction, that this very force will appear to be the cause, and that we may see its mode of operation, if it be really there. To illustrate such a structure, we may take any planet or satellite of the solar system; for all alike have this cosmical force and this inclination of orbital plane, and this recession of nodes.

We take the moon in its revolution. Because of this inclination, one half of its orbit is above and the other half below the plane of the earth's orbit. While the earth is sweeping around in its great orbit, it swings the moon around it, as upon an epicycle of which the earth is the centre. A proper conception of these two motions in relation to each other gives us the direction of the central force which produces the moon's motion.

It is never directed from a point fixed as the centre of the orbit, nor from a straight line, constituted by a motion of such a point, but from a centre always moving in a line curving eastwardly, and in a direction differing from that of the moon's orbit according to the different inclinations of the earth's and the moon's orbits. It is the very force which bears the moon forward in space, and yet, by reason of the form of their connection, it is always moving laterally and eastwardly out of the centre of the moon's plane, and tending also to push forward through and beyond the plane, and thus it is all the while exerting its force in a sort of twisting of the moon's orbit into perpetual accommodation to the curve of the orbit of its primary.

The result of this is, that no matter what may be the position of the moon's plane, this force, always departing from a right line, constantly draws the moon down or up through the plane of the earth's orbit sooner in each successive revolution; and this is equivalent to a westward warping or tilting motion of the moon's plane, so that it cuts that of the earth more and more westward in each revolution; and this would constitute a constant recession of the nodes, even if there were no other causes of it; and it ought not to be overlooked.

If this is a correct reading of this force and its dependent motions, which I submit to those who may consider the subject worth thinking about, then the central force of every planet operates in precisely the same form on its satellites, where their orbital planes are inclined, varied only according to their degrees of inclination. And, of course, the sun (assuming its motion to be as heretofore stated) operates in the same way upon all the planets, so as to produce a recession of their nodes; and the phenomenon of recession of nodes, even if not entirely normal, has a perfectly normal cause.

It follows also, that wherever we find a constant recession of the nodes of a secondary body, we may naturally infer that its primary is itself revolving around some central body; though it will be impossible to say that

this product of the central force may not be entirely merged in the product of some disturbing force.

Dr. Whewell regards the discovery of the precession of the equinoxes, resulting from the attraction of the sun and moon on the earth's equatorial protuberance, as a remarkable example of the consilience of inductions; but surely this consilience is more impressive when we notice that that form of attraction is enterely singular, not being known to exist in any other, even analogous, case; whereas, the form here suggested applies to every case where there are revolving nodes; that it presents the motion as a perfectly normal consequence of the central force of each system or sub-system, operating directly upon its dependent body according to the relation of its orbit; and that it recognizes a physical, along with a formal, unity in the plan of the whole system, and satisfies the second of Newton's "Rules of philosophizing," that "Natural effects of the same kind are to be referred to the same cause, so far as can be done." The other theory has this difficulty to contend with: that we suppose all planets to have equatorial protuberances, as an effect of rotation; and, so far as we know, all have inclined axes; and yet we do not attribute to them precession of equinoxes and recession of nodes as two different motions. Both exist, but only as different aspects of the same motion.

But the views here presented are not without serious difficulty in their ulterior application. If the cause here suggested is true, then it seems natural to seek some proportion in time between the revolutions of the nodes and those of the central bodies on which they depend; a proportion modified by the differences of relation in space and time in which the several secondaries stand to their primaries. I do not discover the law of such a proportion, or even that it surely exists. If it were discovered it would probably be of use in seeking the period and orbit of the sun's revolution.

So far as our knowledge goes at present, we find that it always requires many revolutions of a planet or satellite for one revolution of its nodes, and they differ very greatly. In one revolution of its nodes Mercury revolves in its orbit over 500,000 times; Venus, 100,000; the earth, 25,000; Mars, 27,000; Jupiter, near 7,000; Saturn, 2,200; and Uranus, 428. No others revolve in so short a *time* as those of the earth. Among the satellites, the moon revolves 230 times for one revolution of its nodes; Jupiter's 2d satellite, 3,000; its 3d, 7,000; its 4th, 11,000 times.

And in all known cases the central body revolves more frequently than the nodes of its dependent. Thus the earth revolves in its orbit near 19 times for one revolution of the moon's nodes; Jupiter 2½ times for once of the nodes of its 2d satellite, 12 times for its 3d, and 45 times for its 4th satellite. All this would seem to indicate a period for the sun's revolution round its unknown centre, which would be a very small fraction of any estimate of it that I have seen, founded on observations of stellar parallaxes. I find no clue to the solution of this apparent anomaly; I hope some other inquirer may.

ON THE MEDICAL ACTIVITY OF THE HEMP PLANT, AS GROWN IN NORTH AMERICA.

By Dr. Horatio C. Wood, Jr., Prof. of Botany, University of Pennsylvania; Secretary of the Committee of the College of Physicians of Philadelphia on the Revision of U. S Pharmacopeia.

A prize essay, read before the Amer. Phil. Soc., Nov. 19, 1869.

Almost from time immemorial various preparations of the hemp plant have been used in India for the production of a peculiar intoxication. These, or allied preparations have also in modern times been largely used in medicine. It has been thought by some that the hemp of India is specifically distinct from the European plant, but there are really no specific differences, the former differing from the latter only in minor particulars, such as size, the results of the modifying influences of soil and climate. As the drug has become an important article of commerce, attempts have been made to obtain the medicinal principle, a peculiar resinoid body, from plants grown in Great Britain, by which it has been determined that although the resin does exist in such plants, yet it is in so small quantity, that they are not available for manufacturing purposes. The summers of England appear to be too cool to enable the hemp to elaborate its peculiar resin in any quantity. The world has, therefore, been dependent upon India for its supplies of this widely used narcotic. The plants with which the following experiments were made, were raised in the vicinity of Lexington, Kentucky. They were male plants, which had been grown for the purpose of fertilizing seeding female plants, and which having fulfilled that office, were of no further value to the cultivator. They were obtained for me, by R. B. Hamilton, Esq. of Lexington, to whom my thanks are due for the trouble taken by him to aid my investigation.

The first experiment was as follows: an ounce and a half of the powdered leaves, were treated with hot alcohol, although not to exhaustion. The tincture thus made was evaporated and an alcoholic extract obtained. About 4½ P. M., Sept. 22d, I took most of this extract, in a lump, which a druggist estimated to contain from 20 to 30 grains. No immediate symptoms were produced. About 7 P. M., a professional call was requested and forgetting all about the hemp, I went out and saw my patient. Whilst writing the prescription, I became perfectly oblivious to surrounding objects but went on writing, without any check to or deviation from the ordinary series of mental acts, connected with the process, at least that I am aware of. When the recipe was finished, I suddenly recollected where I was, and looking up, saw my patient sitting quietly before me. The conviction was irresistible, that I had sat thus many minutes, perhaps hours, and directly, the idea fastened itself that the hemp had commenced to act, and had thrown me into a trance-like state of considerable duration, during which I had been stupidly sitting before my wondering patient.

I hastily arose and apologized for remaining so long, but was assured

I had only been a very few minutes. About 7½ P. M. I returned home. I was by this time quite excited, and the feeling of hilarity now rapidly increased. It was not a sensuous feeling, in the ordinary meaning of the term; it was not merely an intellectual excitation, it was a sort of *bien-être* — the very opposite to *malaise*. It did not come from without; it was not connected with any passion or sense. It was simply a feeling of inner joyousness; the heart seemed buoyant beyond all trouble; the whole system felt as though all sense of fatigue were forever banished; the mind gladly ran riot, free constantly to leap from one idea to another, apparently unbound from its ordinary laws. I was disposed to laugh; to make comic gestures—one very frequently recurrent fancy, was to imitate with the arms the motions of a fiddler, and with the lips the tune he was supposed to be playing. There was nothing like wild delirium, nor any hallucinations that I remember. At no time had I any visions, or at least any that I can now call to mind; but a person, who was with me at that time, states that once I raised my head and exclaimed, "Oh, the mountains! the mountains!" Whilst I was performing the various antics, already alluded to, I knew very well I was acting exceedingly foolishly but could not control myself.

I think it was about 8 o'clock, when I began to have a feeling of numbness in my limbs, also a sense of general uneasiness and unrest, and a fear lest I had taken an overdose. I now constantly walked about the house, my skin to myself was warm, in fact my whole surface felt flushed; my mouth and throat were very dry; my legs put on a strange, foreign feeling, as though they were not a part of my body. I counted my pulse and found it 120, quite full and strong. A foreboding, an undefined, horrible fear, as of impending death, now commenced to creep over me; in haste I sent for Dr. H. Allen, and he being out, directly afterwards for Dr. Thomas. The curious sensations in my limbs increased. My legs felt as though they were waxen pillars beneath me. I remember feeling them with my hand and finding them, as I thought at least, very firm, the muscles all in a state of tonic contraction. About 8 o'clock, I began to have marked "spells"—periods when all connection seemed to be severed between the external world and myself. I might be said to have been unconscious during these times, in so far that I was oblivious to all external objects, but on coming out of one, it was not a blank, dreamless void upon which I looked back, a mere empty space, but rather a period of active but aimless life. I do not think there was any connected thought in them; they seemed simply wild reveries, without any binding cord; each a mere chaos of disjointed ideas. The mind seemed freed from all its ordinary laws of association so that it passed from idea to idea, as it were, perfectly at random.

The duration of these spells to me was very great, although they really lasted but from a few seconds to a minute or two. Indeed I now entirely lost my power of measuring time. Seconds seemed hours; minutes seemed days; hours seemed infinite. Still I was perfectly conscious during the intermissions between the paroxysms. I would look at my watch, and then after an hour or two, as I thought, would look again and

find that scarcely five minutes had elapsed. I would gaze at its face in deep disgust, the minute hand seemingly motionless as though graven in the face itself; the laggard second hand moving slowly, so slowly. It appeared a hopeless task to watch during its whole infinite round of a minute, and always would I give up in despair before the 60 seconds had elapsed. Occasionally, when my mind was most lucid, there was in it a sort of duplex action in regard to the duration of time. I would think to myself it has been so long since a certain event, an hour for example, since the doctor came, and then reason would say, no it has been only a few minutes, your thoughts or feelings are caused by the hemp. Nevertheless I was not able to shake off this sense of the almost indefinite prolongation of time, even for a minute. The paroxysms already alluded to, were not accompanied with muscular relaxation. About quarter before 9 o'clock, I was standing at the door, anxiously watching for the doctor, and when the spells would come on I would remain standing, leaning slightly, perhaps, against the doorway. After awhile, I saw a man approaching, whom I took to be the doctor. The sounds of his steps told me he was walking very rapidly, and he was under a gas lamp, not more than one-fourth of a square distant, yet he appeared a vast distance away and a corresponding time approaching. This was the only occasion, in which I noticed an exaggeration of distance; in the room it was not perceptible. My extremities now began to grow cold and I went into the house. I do not remember further, until I was aroused by Dr. Thomas shaking or calling me. Then intellection seemed pretty good. I narrated what I had done and suffered, and told the doctor my opinion was, that an emetic was indicated both to remove any of the extract still remaining in my stomach and also to arouse the nervous system. I further suggested our going into the office as more suitable than the parlor, where we then were. There was at this time a very marked sense of numbness in my limbs, and what the doctor said was a hard pinch, produced no pain. When I attempted to walk up stairs my legs seemed as though their lower halves were made of lead. After this there were no new symptoms, only an intensifying of those already mentioned. The periods of unconsciousness became at once longer and more frequent, and during their absence intellection was more imperfect, although when thoroughly roused, I thought I reasoned and judged clearly. The oppressive feeling of impending death became more intense. It was horrible. Each paroxysm would seem to have been the longest I had suffered: as I came out of it, a voice seemed constantly saying, "you are getting worse—your paroxysms are growing longer and deeper—they will overmaster you—you will die."

A sense of personal antagonism between my will power and myself, as affected by the drug, grew very strong. I felt as though my only chance was to struggle against these paroxysms; that I must constantly arouse myself by an effort of will, and that effort was made with infinite toil and pain. I felt as if some evil spirit had control of the whole of me, except the will power, and was in determined conflict with that, the last citadel of my being. I have never experienced anything like the fearful sense of almost hopeless anguish and utter weariness which was upon me.

Once or twice during a paroxysm, I had what might be called night-mare sensations; I felt myself mounting upwards, expanding, dilating, dissolving into the wide confines of space, overwhelmed by a horrible, rending, unutterable despair. Then with tremendous effort, I seemed to shake this off, and to start up with the shuddering thought, next time you will not be able to throw this off, and what then! Under the influence of an emetic I vomited freely without nausea and without much relief. About midnight, at the suggestion of the doctors, I went up stairs to bed. My legs and feet seemed so heavy I could scarcely move them, and it was as much as I could do to walk with help. I have no recollection, whatever, of being undressed, but am told I went immediately to sleep. When I awoke early in the morning, my mind was at first clear, but in a few minutes the paroxysms, similar to those of the evening, came on again, and recurred at more or less brief intervals until late in the afternoon. All of the day there was marked anæsthesia of the skin.

At no time were there any aphrodisiac feelings produced. There was a marked increase of the urinary secretion. There were no after effects, such as nausea, headache, or constipation of the bowels.

The following notes were kindly furnished by Dr. Thomas: "I was called at 8½ P. M. to Dr. H. C. Wood, and was informed he had taken an over-dose of extract-cannab. indic. I found him presenting at first glance, the mental condition and excited manner of mild alcoholic intoxication. His powers of ratiocination were but slightly impaired. The most prominent psychological manifestation was a constant and overwhelming dread of impending death, which no amount of assurance could relieve for more than an instant; with this was combined an almost entire loss of the faculty of appreciating time—moments seeming to his disturbed consciousness to be hours in length. He stood and walked without difficulty, and his voice was natural in tone and accent. Pupils widely though not completely dilated; pulse moderately full, and numbering 106 beats per minute, increasing in frequency to 118 per minute within the following twenty minutes and becoming decidedly weaker. The extremities were cool and growing colder. Zinci Sulph. was now ordered with the view of evacuating the stomach of any of the drug which might remain unabsorbed, as well as for any possible revulsive influence it might exert. At ten minutes after 9, when the emetic was obtained, the pulse was found to have increased in frequency still farther (136) and to have proportionately decreased in volume. Within 15 minutes following, the feet meantime having been soaked in hot mustard water, free emesis took place, and the pulse rapidly fell, improving at the same time in quality. At 10.15 it was 104 per minute, and it remained about the same for the succeeding hour. The warmth of skin was at this time restored. The mental state varied but little throughout. At 11.15 I resigned the case to Dr. Allen."

The foregoing experiment proves that the Kentucky hemp does contain an appreciable quantity of the resinous active principle or principles, but it was merely tentative, and was not intended to determine the proportionate amount.

In order to determine the proportion of extract obtainable, the following experiment was performed:

Six ounces of the dried leaves of male Kentucky hemp plants were treated with hot alcohol and then exhausted with a little ether. The tinctures thus obtained were mixed and evaporated. The extract thus procured weighed 252 grains. One drachm of it was rubbed up with a strong solution of the Carbonate of Soda to remove fatty matters, &c. It lost nineteen grains or 32 per cent., very nearly one-third of its weight. Six ounces of the leaves, therefore, yielded rather more than two and two-thirds drachms of an extract, from which every thing soluble in an alkaline solution had been removed. The method employed resembles that of the Messrs. Smith of Edinburgh. They obtained from 6 to 7 per cent. of their purified extract from the plant grown in India. I obtained 4 to 5 per cent. of the extractive, and as the operation was on a small scale and conducted by one totally unversed in practical pharmacy, there can be no doubt that there was sufficient loss to bring up the proportion fully to 5 per cent.; moreover the American leaves were probably not so thoroughly dried as the Indian.

The therapeutic powers of this extract were not tested.

To test the matter further, I exhausted three ounces avoirdupois with hot alcohol, and the resultant tincture was placed in the hands of Hance, Griffith and Company, Manufacturing Chemists of this city.* Four-fifths of this tincture were evaporated by them to the consistency of a syrup, and to it was added ten times its bulk of water. The precipitate was washed and dried. When given into my hands, it was a softish greenish, adhesive resin. Of this I took $\frac{3}{4}$ of a grain dissolved in a mixture of alcohol and ether. It produced marked cerebral disturbance amounting to a mild intoxication.

These symptoms were similar to those heretofore detailed, but very much milder. There were, however, no marked periods of unconsciousness, merely a feeling of hilarity and a total inability to fix the attention except for a very short period and also some prolongation of time.

Of this same resinous extract, my friend, Carl Früh, a graduate of the Philadelphia College of Pharmacy, took one grain. He first felt the influence of it about supper time. His head felt as if some one was violently compressing it and at the same time there was a feeling of hilarity, with an uncontrollable desire to talk and laugh, so that those around him asked him what had come over him.

At supper he was almost ravenous and ate so much that it was noticed by others. Upon attempting to concentrate his thoughts upon any subject, he found it required a very painful effort. In attempting to compound a prescription, he found it impossible to remember more than one ingredient at a time, and even this was almost beyond his powers. In the evening he went to a lecture at the College of Pharmacy. Although he understood all that was said, yet he could not remember it a moment, and at times would forget his surroundings and then suddenly wake up to find himself sitting in the lecture room. Later in the evening he attended a society-meeting, and afterwards went out with a fellow student, but has no recollection of what was said or done. There was a good deal of pria-

*Now Hance, Brothers and White.

pism during the night, and a state of venereal excitement was induced, lasting several days. During the night, urine was passed very freely. Before this, he had taken two grains of Herring's extract with the result of producing similar symptoms, which were, however, no more intense than those caused by the single grain of the American resin.

Messrs. Hance and Griffith prepared the resin from the remainder of the hemp tincture, by first agitating with milk of lime, filtering, precipitating by sulphuric acid, agitating with animal charcoal, again filtering, concentrating by evaporation, and precipitating the resin by the addition of twice the bulk of water. The resin thus obtained was tested by my friend, Dr. Richardson, in the Pennsylvania Hospital, by permission of Dr. Da Costa, the attending physician. One-fourth of a grain of it was found to be sufficient to produce decided therapeutic results; in some cases acting very pleasantly as a hypnotic and calmative; in others, causing evident sensorial disturbance, but rather aggravating than alleviating the distress of the patient.

Having at that time a lady under my care, subject to severe attacks of neuralgia, I supplied her with some of the drug in $\frac{1}{4}$ grain pills. Of these she found one was always sufficient to induce a quiet sleep of some hours duration, from which she generally awoke free from pain. After the limited supply of this preparation was exhausted, I tried with her a similarly prepared extract made from imported India hemp plants, but a grain of this did not suffice to quiet the pain and induce sleep.

The above experiments are certainly sufficient to prove that the hemp plant, as grown in Kentucky, contains a sufficient abundance of the active principle, to be capable of yielding a supply to the pharmaceutist. If I am correctly informed, the India plant is worth at wholesale prices, about a dollar a pound in our market. The male seeding plants in Kentucky, after they have shed their pollen, are worthless. It was with such plants the experiments were instituted. A considerable supply of them might be obtained, so Mr. Hamilton writes me, for little more than the expense of gathering them, or if the demand should exceed the amount of such male plants, the leaves of the female plants when ready to be cut for the fibre might be obtained on the same terms.

A more important consideration than the mere monetary one, is the probability that, when the plants were raised near home, a more uniform product would be obtained.

There can be no doubt, that under certain circumstances cannabis indica supplies a medical need, which no other drug will so exactly meet. Yet, the extracts as kept in the shops, even when honestly made, vary so indefinitely in strength, and indeed are so generally almost inert, that the use of this narcotic has been largely abandoned in consequence. It is very probable that this variation depends to a certain extent upon differences in age and modes of cultivation, &c., of the plant. If this be so, the growth of the plant under the eye of the pharmaceutist will give him the opportunity of learning the conditions best fitted for developing in it the active principles.

The U. S. Pharmacopeia apparently recognizes the fact of the variance of the hemp extracts of commerce and directs a purified extract. The process of preparation given, consists simply of dissolving the crude extract in alcohol and evaporating. Unfortunately this does not meet the difficulty, since the solubility of the extract in alcohol is no certain measure of its activity. There are many inert matters existing in the plant which are soluble in alcohol, so that a fair amount of extract may be yielded by a specimen which contains almost no resin. This may occur to a certain extent even if India hemp plant be the subject of the trial and is very certainly the case when plants from other localities are employed.

In order to throw some light on this subject the following experiment was made: 100 grains of a fine looking extract made from India plants wholly soluble in alcohol, were rubbed up with a solution of potash, dissolved in alcohol, passed through animal charcoal precipitated by a strongly alkaline solution, filtered, and the resin carefully washed and dried. The resultant weighed 58 grains. Even if we allow as much as 12 per cent. for waste, there was, therefore, present in the original extract 30 per cent. of inert matters, which corresponds very closely with the amount of inert matter contained in the extract prepared by myself from the American plant. That the matters removed by potash are inert I proved in regard, at least to the American extract, by taking them in considerable amount without any perceptible effects being induced. In view of the above mentioned facts, it would seem advisable to replace in the U. S. Pharmacopeia for 1870, the present *Extractum cannabis purificatum* by a preparation to be called *Resina Cannabis*, and to be made by precipitating the concentrated tincture, by water rendered strongly alkaline by the presence of soda or potash.

Such a mode of preparing is essentially that originally published by the Messrs. Smith of Edinburg. The resin, as obtained by himself in this way, corresponds pretty closely with that described by the latter gentlemen in their original paper. It is fawn colored, in very thin layers, but when in mass, is blackish. It is neutral to test paper, and is apparently, a simple, active principle; at least I have not been able to separate any organic principle from it. At one time, I strongly suspected the presence in it of an alkaloid, because its action on myself was so similar to that of the mydriatics.

In order to determine this point, a concentrated tincture was treated with water acidulated with acetic acid, filtered, and to the clear solution thus obtained an alkali was added, but no precipitate was afforded—neither did tannic acid produce any. This experiment was repeated, sulphuric acid being substituted for the acetic. The same negative result was obtained.

Again, a concentrated tincture was treated with freshly precipitated oxide of lead, filtered, the lead removed by the hydro-sulphate of ammonia and the water acidulated with sulphuric acid, was added. Upon again filtering, the clear solution obtained, did not respond to any of the tests for an alkaloid: dilute water of ammonia, filtered through the lead, gave no precipitate with muriatic acid, showing the absence of an insoluble organic acid.

Stated Meeting, Dec. 3d, 1869.

Present, fifteen members.

DR. WOOD, President, in the Chair.

Letters of acknowledgment and envoy, and donations for the Library, were received from the Swedish Bureau of Statistics, Prussian Academy, Physical Society at Geneva, M. M. de Mortillet and de Reffye, Captain Toynbee, the Linnean Society, Franklin Institute, Editors of "Nature," Mr. Isaac Lea, Mr. Dubois, Prof. Haldeman, and Mr. Worthen, of Illinois.

Mr. Du Bois exhibited to the Society, some specimens of silver coin, which have just been struck at the Mint, in illustration of the plan suggested in a pamphlet which lies on the table. There are three pieces of the same devices, of 50, 25, and 10 cents. There are also two pieces of 50 cents, of various devices, with a view to afford a choice, in case the plan should be adopted and legalized. The head of Liberty on one of these, wearing a cap, is copied from the statue at the Capitol.

The dies were designed and executed by the present engraver of the Mint, Mr. William Barber; with the aid of the Hill Engraving Machine.

The main idea which lies at the root of the proposed plan, is, that *gold* is, properly speaking, the only measure of market values; while *silver* should be used only as a subsidiary or fractional currency. It may, or it may not, be of full weight, corresponding to the average comparison with gold. If it is so, it is sure to be snatched away, exported, or buried, whenever a suspension of specie payment occurs. If it be of reduced weight, it will still circulate and perform its functions, although the gold be missing. But at such reduced weight, it should be legally limited, as to amount of issue; and there should also be a close limit of legal tender. With these two safeguards, it would be equally current, whether gold were at a premium, or at par, as compared with bank paper.

The measure of weight last concluded upon, in striking these specimens, is 154 grains for the half dollar; the lesser pieces in proportion. This is four-fifths of the weight of the present silver coins. It also agrees (very closely) with ten grammes of French metrology. Further, it would be 220 *new grains*, if the proposed plan of decimalizing the avoirdupois pound be accepted. And once more, it allows the Mint to buy silver for this coinage, at any line of premium on gold under 30 per cent. as compared with bank notes.

It would therefore, if legally adopted, be current immediately. Further details will be found in the pamphlet referred to.

Mr. Du Bois also exhibited a *medal* just struck at the Mint, to celebrate the union of the two oceans by Railway. On the obverse is the head of President Grant, from an original design. It was deemed proper to indicate under whose administration this great work was completed. On the reverse is a scene representing a train of cars passing from ocean to ocean,

through mountainous ranges; with a legend from the Scripture, "Every mountain shall be made low."

The medal was struck by order of the Director of the Mint, Gov. Pollock, and the dies were made by Mr. Barber.

The opportunity is also taken to show a head of Rittenhouse, in wax, executed by the same artist, from the bust in the Society's hall. It is intended to form the obverse of a medal, by reduction on the engraving machine already spoken of.

Prof. Hayden explained the character of the MSS. Journal of his recent explorations in the Rocky Mountains.

The Annual Report of the Treasurer was read.

The Annual Statement of the Trustees of the Building Fund was read, and the Society was adjourned.

Stated Meeting, Dec. 17th, 1869.

Present, fourteen members.

Dr. Wood, President, in the Chair.

Letters were read from Mr. H. A. Homes, of Albany, State Librarian, from the Natural History Society at Newcastle upon Tyne, and from Dr. F. V. Hayden, withdrawing his paper, on account of its ensuing publication by the Department of the Interior at Washington.

Donations for the Library were received from the London Geological Society, the Boston N. H. Society, Mr. Homes of the N. Y. State Library, the College of Pharmacy, Mr. David Paul Brown, Mr. Hector Orr, Gen. A. A. Humphreys and the Department of the Interior.

A letter was read from the Chairman of the Publication Committee, Mr. James, relative to the publication of Dr. Dewey's Report on Carices. On motion of Mr. Fraley, the papers were recommitted to the original Committee, Mr. Durand, Mr. James and Dr. Ruschenberger.

A communication was made by Mr. P. W. Sheafer of the following records of well borings in the Wilksbarre coal region:

From P. W. Sheafer's Note Book, Engineer of Mines, Pottsville, Pa.

Oxford Shaft near Hyde Park, Luzerne county, Pa.

180 ft. deep to the Diamond coal, which is about 7′ thick.

At 33 ft. cut a 5′ coal through a gangway on which the shaft water is sent to surface; at 65 ft. cut a 6′ Coal.

Further down the Lackawanna is the crop of the 14 ft. Coal, which lies below the Diamond about 80 ft. A small Coal bed divided by a seam of rock lies between.

Audenried Shaft, near Wilkesbarre. From manuscript of Supt. Kendrich, April 5, 1862.

		Surface.
	16′	Sand and Loam.
56	=40′	Sand Stone Rock.
70	=14′	Slate.
80	=10′	Coal.
120	=40′	Slate.
120½	= ½′	Coal.
160½	=40′	Slate.
166½	= 6′	Coal.
176½	=10′	Fire Clay.
226½	=50′	Slate.
228	= 1½′	Coal.
238	=10′	Fire Clay.
259	=21′	Mixed Sand Stone.
264	= 5′	Slate.
269	= 5′	Coal.
296	=27′	Fire Clay and Slate.
328	=32′	Mixed Sand Stone.
335	= 7′	Coal.
338	= 3′	Fire Clay.
395	=57′	Black Rock.
400	= 5′	Coal.
415	=15′	Mixed Sand Stone.

Empire Shaft near Wilkesbarre, April 5, 1862, from Surveyor Allerbach's notes, who got it from Broderich, Supt.

From	Surface	to	bottom	of	10′	Vein Coal is	80′
	"		"		7½′	"	134′
	"		"		5′	"	220′
	"		"		14′	"	300½′

April 5, 1862. Copy of *Dundee Shaft*, near Monticoke, Wyoming Valley, from Section in Lentz & Co.'s Office, by P. W. Sheafer, E. M., from F. Koerner. Dip 4° S. E.

28′		Surface.
2′	6″	Coal.
9′	6″	———
6′		Fire Clay.
21′		Sand Stone.

	10′		Fire Clay.
	13′		Sand Stone and Slate mixed.
	6′		Slate.
		6″	Coal.
	3′		Slate.
	2′	6″	Coal.
	10′		Slate.
		6″	Coal.
	16′		Slate.
		4″	Coal.
		6″	Slate.
	7′		Sand Stone.
	6′		Fire Clay.
	4′		Slate and Sand Stone.
	5′		Slate.
	4′		Sand Stone and Slate.
	8′		Fire Clay.
	10′		Slate and Fire Clay.
	6′		Sand Stone.
	2′		Fire Clay.
	12′		Slate and Sand Stone.
	11′		Slate, pump.
	2′	6″	Coal.
	14′		Slate.
	15′		Sand Stone.
	17′	6″	Fire Clay and Slate.
	23′	6″	Sand Stone.
		10″	Coal.
		5″	Slate and Coal.
	33′	6″	Slate.
318′	2′	0″	Coal. *Fossil Shells.* No Vegetable impr.
	5′		Sand Stone.
	16′		Slate, Fire Clay, Benches of S. Stone.
	5′	0″	Sand Stone.
	6′		Soft Fire Clay.
	5′	6″	Hard Fire Clay.
	32′	6″	Sand Stone.
	1′	6″	Coal.
	4′		Slate.
	15′		Dark colored Sand Stone.
	20′		Shells. Sand Stone.
	12′		Slate.
	440′	08″	

This shaft was continued to a depth of 700 feet. Its remarkable scientific feature is the fossil shells at a depth of 318 feet.

A communication from Dr. R. J. Roscoe, of Carlisle, Scoharie county, N. Y., to the Librarian, relative to certain supposed fossils of high grade and great size found in the Laurentian rocks of Essex county, New York, fragments of which were brought by Dr. Le Conte, and deposited in the Museum of the Academy of Natural Sciences, in Broad street, was read and commented upon by the Librarian, who explained that they were plications of alternate layers of metamorphosed limestone and sandstone deposits; and that Dr. Leidy had described similar, but much larger ones (one weighing perhaps 20 tons), in the marble quarries near Attleborough, Penn., in a subsilurian group of perhaps the same age. The sheets of graphite covering the plicated layers prove, no doubt, the organic origin of the calc-spar layers; but the present form of the mass ought not to be taken as the original form of the animal organism.

Dr. Geo. B. Wood communicated his experiments and views on the revival of peach and other fruit trees, by the application of potash to their roots. A discussion followed, in which Dr. Coates, Dr. Emerson, Prof. Trego, Judge Lowrie and Gen. Tyndale joined.

Dr. G. B. Wood described a discovery which he believes that he has made, and which, if verified by further experiments, will be of great value to the agricultural interests of the country. Potash, combined with one or more of the vegetable acids, is an essential ingredient in vegetables, particularly in fruit, which, it is probable, cannot be produced without it. Sometimes fruit-trees cease to bear, prematurely; and, in relation to peach trees, it is well-known that, in this vicinity, after producing a few crops, they not only cease bearing, but perish themselves in a short time; whereas their natural life is 50 or 60 years or more. The fact seems to be that potash is wanting in the soil in sufficient abundance to allow the tree to continue to bear fruit continuously. Dr. Wood believes that by supplying potash to the tree, so that it shall reach the radicals, and be absorbed, the deficiency may be supplied; the fruit-bearing power is restored, and the tree itself, if prematurely perishing, revived. He was led to this conclusion in the following way: Having a considerable number of peach trees, which had entirely ceased to bear fruit, and were themselves obviously decaying, and believing, with most persons, that the cause lay in the worms at the root of the tree, he put in operation a plan which he had seen his father perform, more than fifty years since, of digging around the base of the stem a hole four or five inches deep, scraping away all the worms that could be found burrowing at the junction of the stem and root, and filling the hollow thus made with fresh wood-ashes, recently

from the fire, and of course retaining all their potash. The ashes were used with the view of destroying the worms that might have escaped notice. This was done in the autumn of 1868. In the following spring he was himself astonished at the result. The trees appeared to have been restored to all their early freshness and vigor. They put forth bright green leaves, blossomed copiously, and bore a crop of fruit such as they had never borne before; many of the branches breaking down under their load of peaches. In reflecting on these results, Dr. Wood came to the conclusion that all this change could not possibly have been produced by the destruction of a few worms; and, besides, there were several of the peach trees treated, in which no worms could be found. He was thus led to the belief that the real cause of the revival of the trees was the ashes, the potash of which, being dissolved by the rains, had descended along the roots to their rootlets, and presented to them the very food for want of which the trees were dying. He has, accordingly, had hundreds of various kinds of failing fruit trees treated in this way this fall, in the expectation of an abundant harvest next year. Should he live till then, he will inform the Society of the result. Should he not live, the experiment will at least have been put on record.

In answer to an inquiry, Dr. Wood said that the soil was of all kinds, sand, loam, and clay.

Dr. Coates remarked that trees at first grow slowly, and have but little chance to get potash from the limited area which they occupy. For instance, around the body of large trees there are seldom other growths.

Dr. Emerson gave his experience of peach growing. The peach, brought from Persia, loves a mild climate, and suffers when brought North, unless protected. When first brought to this country it grew luxuriantly, in all parts, well. Of late years, however, owing to the clearing away of the forest, which afforded it the same kind of protection which, in Northern Europe, was given it by glass, it has become limited to the soft climate of the peninsula between the Delaware and Chesapeake Bays, where it has no disease and bears abundantly. The "Yellows," however, although looked upon as a disease spreading from tree to tree, is in fact produced by colonies of a parasite, which propagates under favor of a low constitutional condition of the tree, produced by the failure of the necessary climatic protection. As to the nourishment of the tree, salts, especially of potash, are very nutritive. But there is another element in wood ash, phosphorus, which is the prime mover of all vegetable life. Dr. Emerson described one of his unpublished experiments, with a peach orchard, which yielded inferior fruit, but only as to *color;* otherwise the fruit was as good as others. He gave a top dressing of 200 or 300 lbs. of superphosphate to the acre, and the next year his peaches brought 10 or 20 cents more in the market. At a certain exhibition, some pears of a very high color were displayed, which brought a very high price. Their rearer had used dog dung in quantities, which lent additional force to Dr. Emerson's belief that phosphoric acid heightened the color of his peaches.

Dr. Wood repeated that his experiment bore especially upon the mode

of application of the potash. The spreading of potash over the surface of the land produced no great result. But, when placed where the rain water could carry it along the descending roots down to the rootlets, it is immediately absorbed by the plant, and produces its effects.

Judge Lowrie said that he bought, in 1838, a wild place near Pittsburgh. It was covered with forest trees and underbrush. He cleared away the undergrowth and weeds. Within three years he discovered that all the walnut and hickory trees were beginning to die, although in rich soil, and 4 or 5 feet in diameter, and some of them one hundred feet high. In the course of two years none were left. The oaks, maples, lindens and elms were not affected.

Prof. Trego said that in Bucks county, black walnut trees, planted along the fences, grow and flourish well, and are not hurt by standing quite alone as shade trees. He had placed wood ashes around the foot of a fine pear tree, banking it up around the tree, but it had no effect. Peach trees have many roots running horizontally, and the rootlets are near the soil. To this Dr. Wood replied that, according to his observations, they descend into the ground obliquely.

General Tyndale said that the finest peach grounds in the United States are the highlands of Southeastern Tennessee; the tops of mountain spurs of the Cumberland plateau, around Chattanooga, above the conglomerates of the Coal Measures and the cavernous limestones of the sub-carboniferous, two thousand feet or more above sea-level, and many hundred miles in the interior of the country.

The stated business of the meeting being in order, the Report of the Financial Committee was read, and, on motion, the appropriations, recommended therein for the ensuing year, were passed, as follows:

Salary of Librarian	$700 00
Salary of Assistant to Librarian	360 00
Salary of Janitor	100 00
Binding Books	150 00
Subscription to Journals	50 00
Petty expenses of Librarian	100 00
Hall account	200 00
Insurance account	160 00
Publication, in addition to the interest of the publication fund.	2,000 00
General expenses, other than the above, and including the commissions of the Treasurer	750 00
	$4,570 00

Pending nominations, Nos. 643 to 648 were read.

Mr. Fraley moved that the subject of cleaning and varnishing the portraits of the Presidents of the Society, be referred to the Committee on the Hall, with power to act.

And the Society was adjourned.

SECOND ADDITION TO THE HISTORY OF THE FISHES OF THE CRETACEOUS OF THE UNITED STATES.

By Edw. D. Cope.

Beryx insculptus, *Cope.*

This species is established on a specimen obtained by Samuel Lockwood, Director of Public Schools for Monmouth county, N. J., from the lower green sand-bed in the same county. A second specimen was found by Jno. Meirs, in the dark clay marl, just below the upper green sand-bed, at Hornerstown, Monmouth county. This one is in possession of Prof. O. C. Marsh, of Yale College.

The species is stout, and covered with very large, thick scales. The fins are not well preserved, but radii of all but the pectorals remain, and are of stout proportions. The scapular arch and cranium are strongly marked with narrow, elevated ridges, which form a reticulate relief. The scales are large and narrowly exposed below the lateral line, There are seven longitudinal series below this line, and not less than two above; there are twenty-three in the lateral line, and possibly a few more, as the point of departure from the suprascapula is lost, and greater part of the cranium broken away. The sculpture of the scales consists of a series of radiating ridges, whose interspaces are equal to them, and whose extremities project as short acute points. These ridges are interrupted at a short distance from the middle of the exposed surface, forming irregular obtuse elevations, while the middle of the area is divided by shallow grooves into irregular areas. The whole are sometimes crossed by one or two shallow interrupted concentric grooves. The tubes of the lateral line do not extend behind the middle of the exposed area, and are acute, and with an areolate rugose surface. The depth of the body near the middle is 3 in. 3 lin. below the lateral line; at a short distance behind this point, there is 1 in. 2 lin. above this line, if there are only the two series of scales, visible in the specimen. The length of the species is 5 in. 7.5 lines to what is probably the posterior margin of the pectoral arch. Depth of the caudal peduncle at the base of the fin 1 in. 1 l. Length of a ventral ray 1 in. 7.5 lines, as far as traceable. The dorsal and caudal rays are very stout; a series of small smooth scales continues the lateral line on the middle of the tail.

As compared with the Beryces of the European Cretaceous, B. radians is at once excluded on account of its small scales, and B. germanus, on account of the granulation of the same, as described by Agassiz. The B. levesiensis Mant. (*B. ornatus Ag.*) presents several series of acute mucrones, instead of the single series of the present species, while in the B. microcephalus Ag. the areolation of the middle area of the B. insculptus is wanting, and a greater breadth of the scale is exposed. The B. zippei, from Bohemia, is a much smaller species, and betrays no such strong sculpture of the cranial bones.

This species has not been found in the upper green sand-bed of the New Jersey cretaceous.

SPHAGEPŒA ACICULATA, *gen. et sp. nov.*

Char. gen. This genus is represented by a slender, acute spine, which may be referred either to a Pycnodont or Chimaeroid family. It is nearly straight and slender, and with a thin projecting anterior margin, which is deeply notched from the tip to a short distance above the base, so as to produce an acute dentition. There are no teeth behind, but two prominent ridges separated by a deep groove. Sides of the spine longitudinally grooved.

This spine may possibly be referable to a Plectognath fish. It resembles the spine figured by Dixon (Geol. Sussex XXXII. 7) as belonging to Microdon nuchalis, a Pycnodont. Agassiz, in the Poisson Fossiles, does not ascribe any such species of this family, and says that in Pycnodus the dorsal spines are quite low.

Char. specif. General form much compressed, but the section of the edentulons portion is as broad as deep. Sides with two elevated ridges, of which the anterior only is continued to near the tip, and is gradually broken into a series of tubercles near the base. Length 5.5 lines; greatest width .75 line. This delicate remnant was discovered by my friend Thomas Kite, a naturalist of Cincinnati, Ohio, in the cretaceous green sand of the upper bed at the pits of the Pemberton Marl Company, Birmingham, N. J.

SPHYRÆNA CARINATA, *Cope, Proc. Ac. Nat. Sci. Phila.* 1868, 92.

Founded on a shed example of one of the long teeth, taken from the matrix attached to the dorsal vertebræ of the Elasmosaurus platyurus. The tooth is not very different in outline from that of the S. speciosa Leidy, *i. e.*, sub-triangular, and no more than twice as long as wide at the base. The anterior margin is the more oblique, and its smooth face is margined by a faint line posteriorly, and is continued over the extremity, forming a short obtuse barb on the posterior face. The obtuse face of the tooth behind, sculptured with six or eight deep grooves, which are separated by acute ridges, which do not extend over more than half the length of the tooth. Length a little less than six lines.

From the upper cretaceous of the neighborhood of Fort Wallace, Kansas.

ENCHODUS PRESSIDENS, *Cope.*

This species is similar in size to the E. ferox Morton (Leidy Pr. A. N. Sci. 1855, 397) but differs in the form of the premaxillary bone, and the large tooth which it supports. The basis of the latter is compressed at the base transversely to the axis of the premaxillary bone, so that it has a crescentic section, the concavity backwards. At the middle of the tooth, the section is an equilateral triangle, with an angle (one cutting edge) anteriorly, the inner angle rounded. The plane face of the tooth is thus much reduced in width, and is narrower at the basis than at the middle of the crown. There is moreover a longitudinal groove just in front of the posterior (outer) cutting edge. There is another groove on the other side of the same edge, on the posterior face, and another more marked just inside the anterior cutting edge. In all these points it dif-

fers from the E. ferox, where the section is lenticular, the base triangular ovate, the outer face widening downwards and no grooves. In E. pressidens the base of the tooth projects well beyond the anterior margin of the front of the premaxilliary, while in the E. ferox the reverse is the case. Length of tooth 20.5 lines; transverse width at base 6 lines; longitudinal do. 3.7 lines. Length premaxilla 31.8 lines. depth 15.5.

Two specimens from the cretaceous green sand of New Jersey.

PNEUMATOSTEUS, *Cope.*

This genus is established on a caudal vertebra of peculiar character, It is opisthocoelian, and without trace of suture of either neural or haemal arches. The elements constituting the haemal arch appear to be diapophyses; they are divergent, and probably do not unite distally; they are directed more posteriorly than anteriorly. Their proximal boundary is apparently indicated by an indistinct elevation, perhaps the position of the original suture. The neural arch is split above by a deep median anterior fissure, on each side of which the narrow zygapophyses diverge. There is no zygantrum. The base of the broken neural spine is very small, and is as long as wide; it may probably have had but little elevation.

The structure of the bone is exceeingly light, and the external osseous layer very dense. In order to reduce the weight consistently with the size, the lateral and inferior faces are excavated by deep concavities terminating in pits. There are two on each side separated by a longitudinal ridge-like septum, which is plane with the expanded rims of the cup and ball. The superior pits are beneath the base of the neural spine, and nearly meet under the floor of the neural canal. The inferior concavity is very large, and extends from rim of cup to ball, and is divided longitudinally by a thin laminar hypapophysis. The bases of the diapophyses are wide, and extend from the base of the ball, three-fourths the distance on each side to the rim of the cup.

The form of the vertebra is compressed. The ball is more convex transversely than vertically, and presents a slightly double convexity in profile. This is produced by a slight transverse contraction at the inferior fourth of the vertical diameter. The floor of the neural canal is raised to the superior margin of the ball.

This vertebra resembles the fourth in advance of the first bearing chevron bone in Lepidostues. It differs from it generically, solely in the completeness of the neural arch abone, since it is longitudinally fissured in the existing genus.

PNEUMATASTEUS NAHUNTICUS, *Cope.*

The specific characters of this fossil are as follows: The cup is a vertical oval, slightly truncate below, and openly concave truncate above. Its form is not unlike that seen in some of the Pythonomopha. The neural arch is much contracted transversely opposite the neural spine. The surface of the bone is very smooth, except a few slight rugae near the rim of the cup.

Measurement.

	In.	Lin.
Length of centrum	1	0
Width " " between lateral septa		7.1
Depth of cup		8.4
Width " "		7.9
Depth of ball		8.5
Length base (?) pleurapophysis		6.8
" " neurapophysis		7.
Width neural canal (external, front)		5.2
" " " (internal, behind)		2.8

The large cells are exposed by the fractures of portions of the bone. The largest are at the posterior base of the haemal arch and at the sides of the articular ball, one of the former 1.5 line in diameter. These measurements indicate a gar of six feet in length, if of usual proportions.

The specimen on which this species is established was found by the writer on a pile of miocene marl on the plantation of Nathan Edgerton, in Wayne county, North Carolina. Its interstices are filled with a hard clay matrix, similar to that which adheres to cetacean remains in the hard stratum in the lower part of the miocene shell-bed of that region. Whether it were originally transported from a cretaceous stratum, is not readily ascertainable, as the porous and dense structure of the bone receives fractures rather than rounding from transportation, which cannot be distinguished from those miocene specimens. The color is black. Mus. Cope.

CROMMYODUS IRREGULARIS, Cope. *Phacodus irregularis*, Cope Proc. Bost. Soc. N. Hist. 1869.

The name Phacodus having been given by Dixon to a genus of fishes allied to Pycnodus, from the Tertiary of Sussex, England, the present genus must receive a new name.

ISCHYODUS LATERIGERUS, *Cope sp. nov.*

This species is of about the same size as the I. mirificus Leidy, and presents marked characters. Its extremity is much prolonged, and more flattened than in any other species from the United States. The outer and concave side is elevated by the extent of the anterior exterior crests, which is also remarkably prolonged beyond the dental area which it supports. When the two mandibular rami are in place, it follows from the above, that the median line of the beak is occupied by a deep concavity, which is walled in by the high anterior outer crest. The posterior outer crest is also well developed, and is also prolonged acutely beyond the posterior dentinal area. The latter is oval and very small, less than .33 the anterior. The anterior is long and narrow; its middle marks the anterior extremity of the great inner area. The latter is large in all dimensions, and is undivided. Below it is a slender intero-lateral column. The mandible is thoroughly and regularly curved outwards and backwards. The external terminal column is largely developed vertically.

This species approaches the I. smockii m. but is double the size, is

more compressed and curved, and differs much in the small posterior area, and very long anterior outer crest.

	In.	Lin.
Total length mandible (restored)	6	6
Depth at extremity		9
" " anterior crest	1	6
" " posterior "	2	5
Length posterior outer area		7
" anterior " "	1	7.5
" " " " with crest	2	6
" inner area	2	10.5

From the upper cretaceous green-sand bed at Hornerstown, N. J. Discovered and presented to the writer by Jno. Meirs, proprietor of the excavations at that place.

ISCHYODUS SOLIDULUS, *Cope, sp. nov.*

No distinct external crests, and no anterior outer dentinal area. The posterior outer dentinal area is very small, and looks inwards from the gradual elevation of the outer superior margin. The inner area is very large and undivided, and is accompanied on the inner margin by a slender column, which issues in the posterior corner of the symphyseal plane. The terminal area of the beak instead of having the usual narrow oblique form, is the round extremity of a narrow column. Inner and outer margins, anterior to the large area, of equal elevation, regularly curved outwards without angulation.

	In.	Lin.
Length (restored)	2	6.5
" to end inner area	1	9
" " " posterior outer		10.5
" of " "		2.5
" " inner	1	9
Depth at "		9.2
" " posterior	1	2
" " beak		4.5

This species is nearest the I. divaricatus m. It differs in many respects, among which are the absence of anterior outer area, and of prominence of the inner lip, and the great reduction of the terminal column. Its lack of dental development allies it to the Leptomylus m. Size, small.

From the same locality and donor as the I. laterigerus.

PRISTIS ATTENUATUS, *Cope.*

Tooth slender, width at base less than one-sixth length, thick and straight. Posterior face straight, with a wide groove, anterior curved backwards, obtuse with a faint median longitudinal groove. Posterior face at the tip of the tooth, oblique. No striae.

Length 26.7 lines; width 4.5 lines; depth at base 3 lines.

This species is much more slender than the P. agassizii Gibbes, the only species which resembles it. Found by Prof. W. C. Kerr, State Geologist of North Carolina, at Flower's marl pit, Duplin Co., N. C.

ERRATA.

Page 100, Eighteenth line from the bottom, read "proposed" for "prepared."

Page 167, twelfth line from the bottom, for "relations" read "dilatations."

Page 168, eighteenth line from bottom, omit "been."

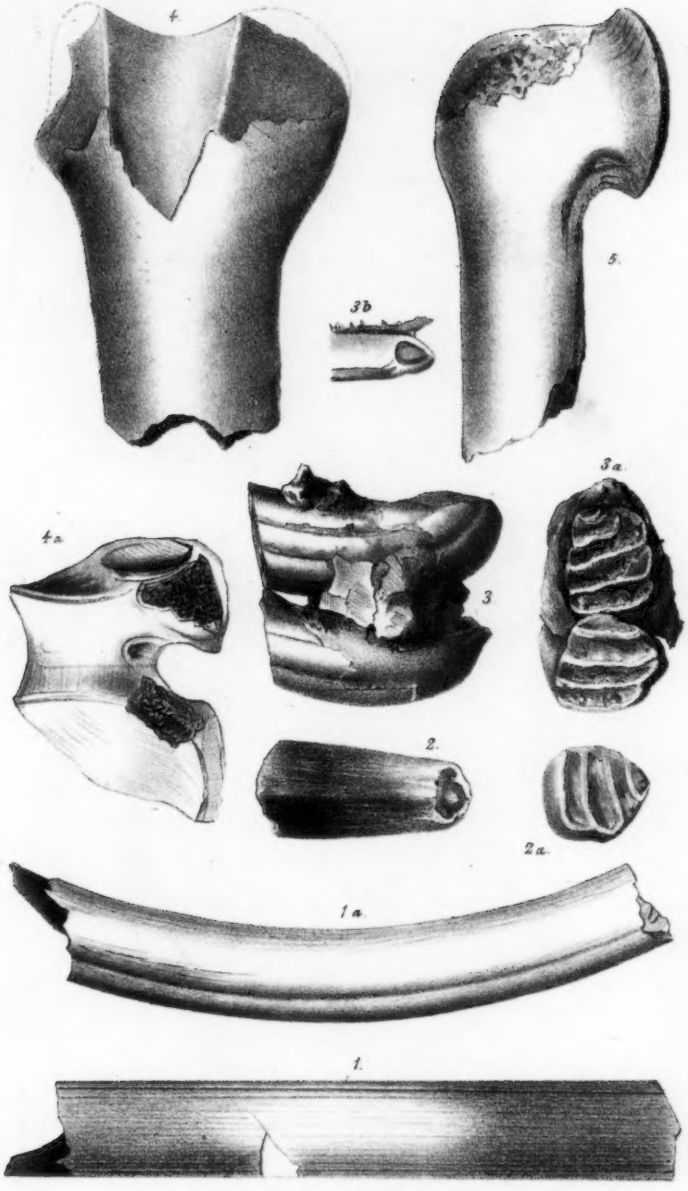
Page 168, seventh line from bottom, for "Esophus" read "Eusophus."

Page 171, fifteenth line from bottom, for "miles" read "miles distant."

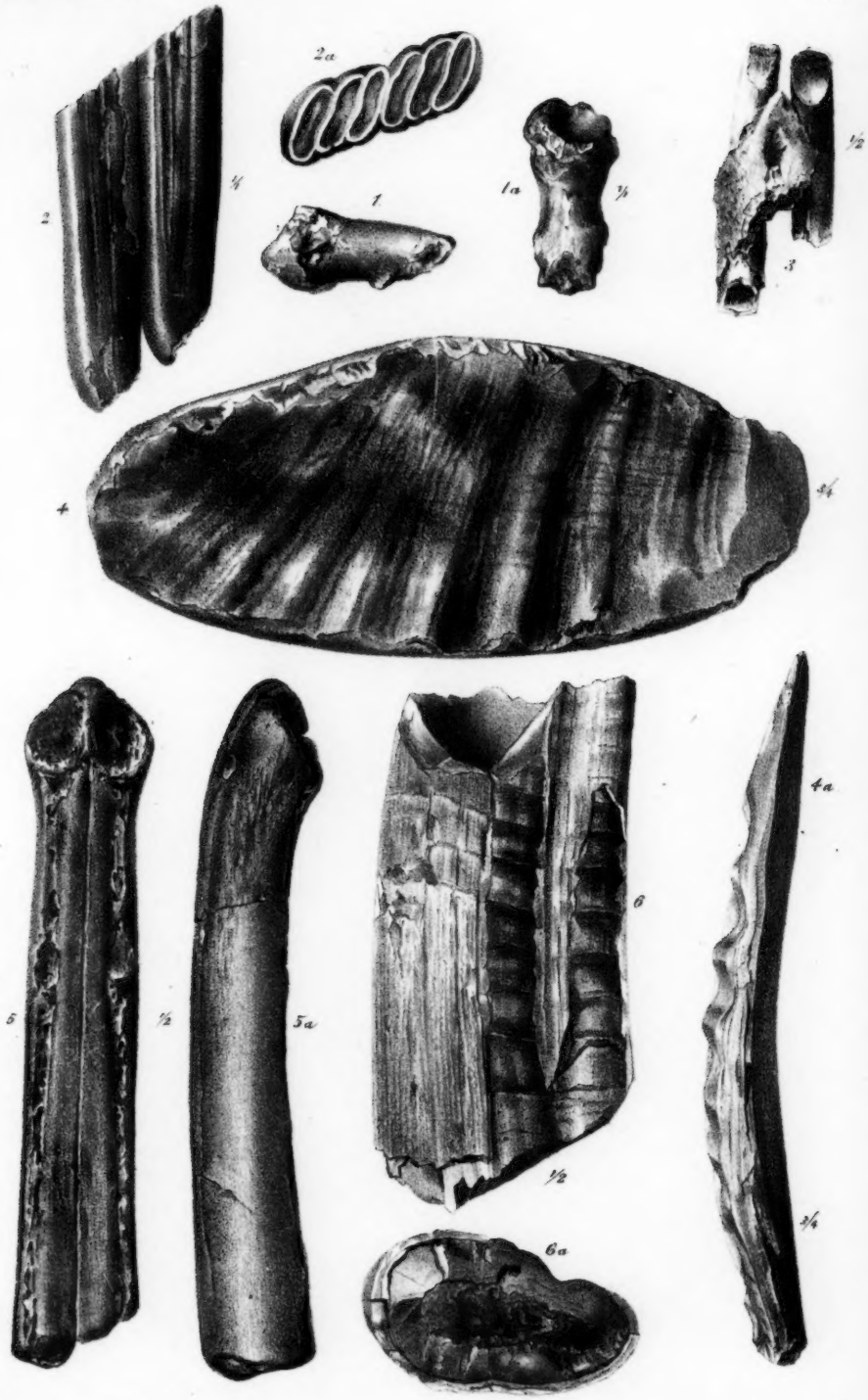
Page 188, line 15, omit "not."

Page 188, line 17, for "though" read "and."

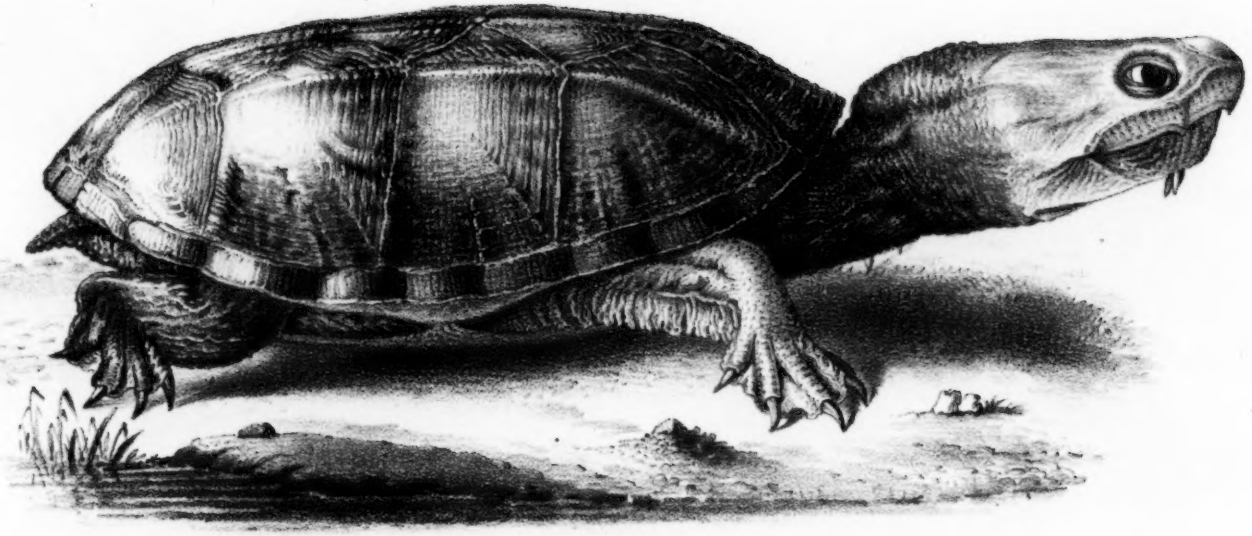
1. Galera perdicida. 2. Mixophagus spelaeus. 3. Stereodectes tortus.
4. Tamias laevidens. 5. Sciurus panolius. 6. Tapirus haysii.



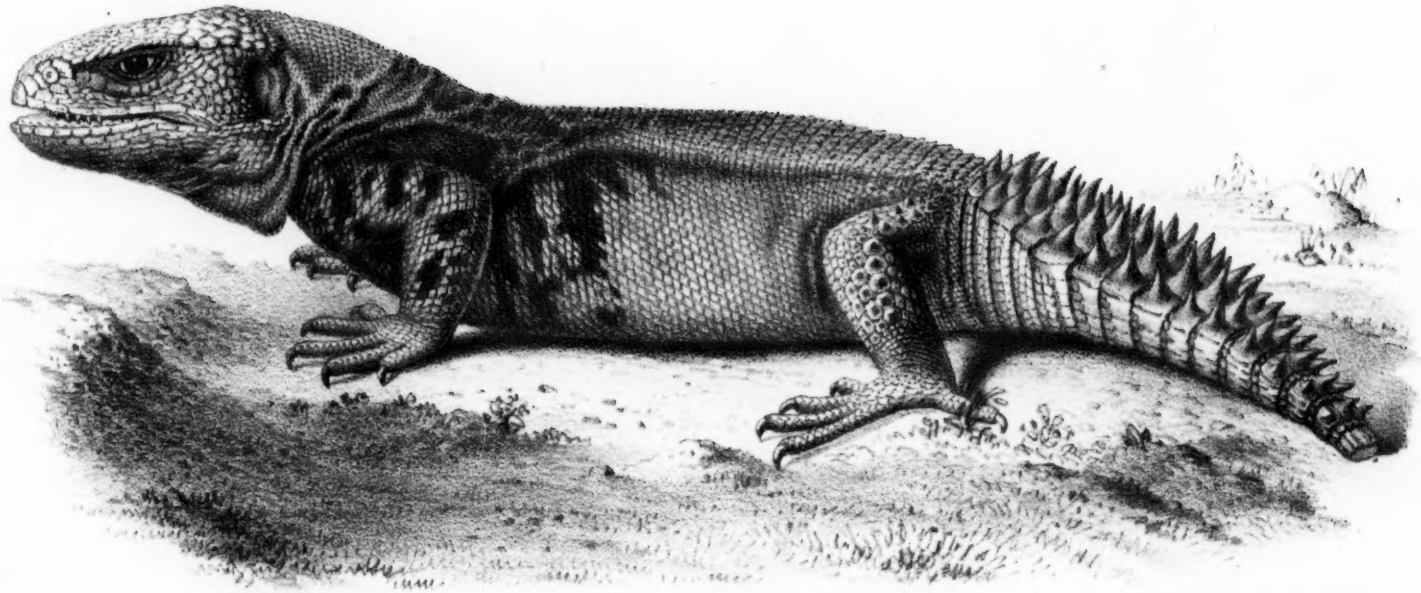
Amblyrrhiza inundata. Cope.



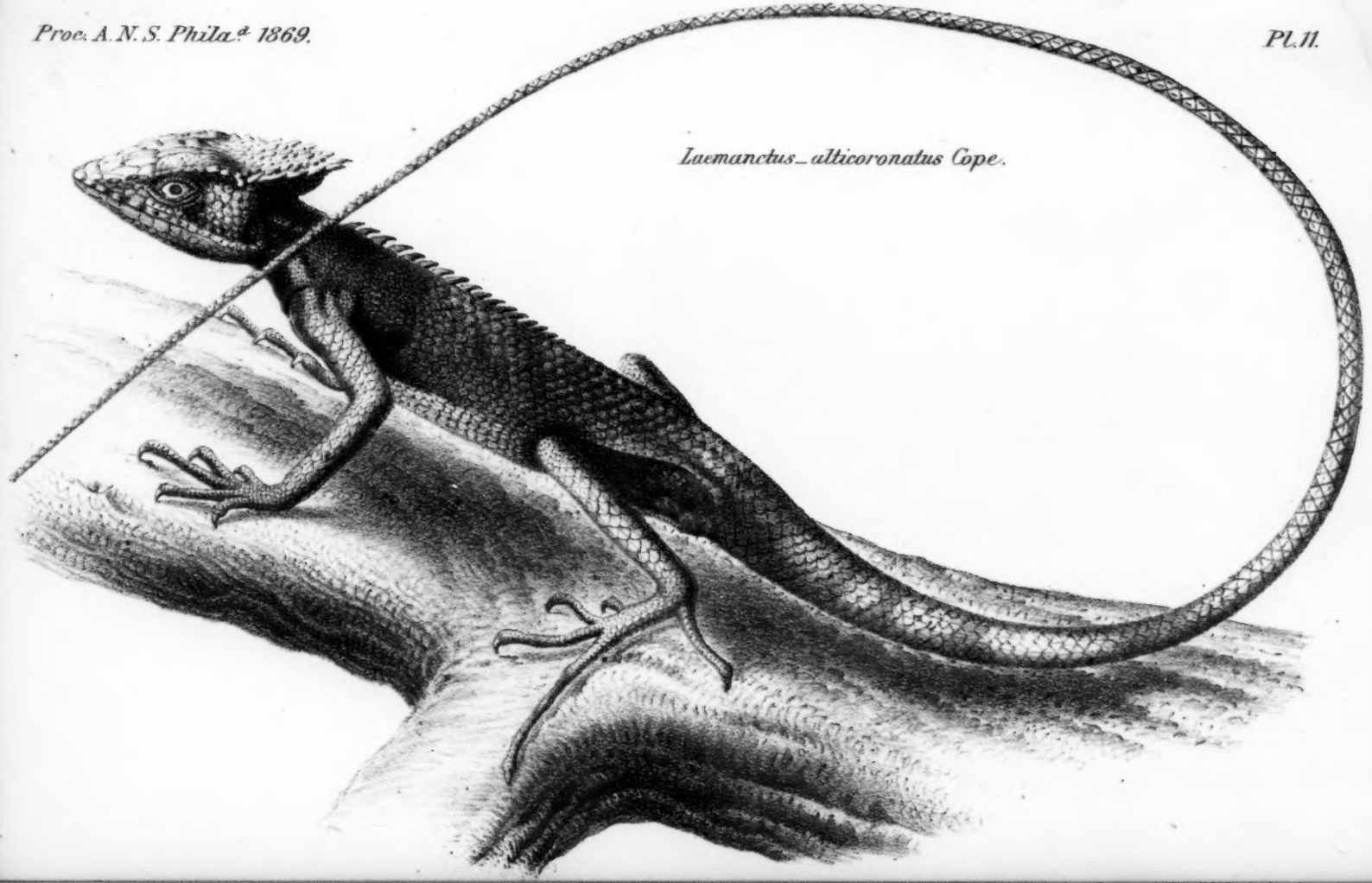
1. Amblyrhiza inundata 2 - 3 Loxomylus longidens. 4 Shell implement.
5 Anoplonassa forcipata. 6 Hemicaulodon effodiens.



Claudius angustatus Cope.



Cuchryx defensor Cope.



Laemanctus_alticoronatus Cope.

Newly elected members will receive their diplomas through the Smithsonian Institution, or by private hands; and all members, who have not already sent their CARTES DE VISITE for the Album of the Society, are respectfully urged to do the Society this favor at their early convenience, by mail or otherwise.